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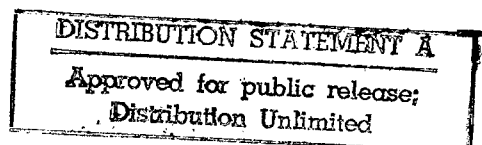
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# ***JPRS Report***

# **Science & Technology**

***Europe***

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## NOTICE

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# Science & Technology Europe

JPRS-EST-88-001

## CONTENTS

10 MAY 1988

### WEST EUROPE

#### ADVANCED MATERIALS

French Standardization Efforts for Advanced Materials Testing Review [Pierre Priester; <i>ENJEUX</i> , No 86, Dec 87]	1
CISE-FIAR Claims European Leadership in GaAs Cell Production [L. Bertotti, et al.; <i>ALTA FREQUENZA</i> , No 5, Jul 87]	8
Italy's Ginatta Titanium-Producing Process Described [Gianmichele Orsello; <i>NOTIZIARIO TECNICO AMMA</i> , Sep 87]	19
CIM Research Expands in Scotland [VDI <i>NACHRICHTEN</i> , 8 Jan 88]	20

#### AEROSPACE, CIVIL AVIATION

Future Post Ariane 5/Hermes Space Launchers [DORNIER <i>POST</i> , No 3, 1987]	20
Highly Precise Reflectors, Mirrors in Fiber-Composite Technology [DORNIER <i>POST</i> , No 3, 1987]	26
Dornier's High-Power Amplifier in Microwave Frequency Range Outlined [Philipp Sopper, Kurt Rogalla; <i>DORNIER POST</i> , No 3, 1987]	27
MBB Starts HERMES Development Program [VDI <i>NACHRICHTEN</i> , 15 Jan 88]	31
BMFT, MBB-ERNO, KRUPP ATLAS Subsidize Microgravity Facility [Margarete Pauls; <i>VDI NACHRICHTEN</i> , 15 Jan 88]	32
A330/340 Assembly: New Facility, Technique Described [Helga Hillebrand; <i>FLUG REVUE</i> , Feb 88]	33
No Variable Camber Wing for New Airbus Model [Helga L. Hillebrand; <i>FLUG REVUE</i> , Feb 88]	34
First Fokker 100 Delivered Amid New Delays, Orders, Financial Questions	34
First Delivery [ANP <i>NEWS BULLETIN</i> , 1 Mar 88]	34
New Delays, Orders [ANP <i>NEWS BULLETIN</i> , 3 Mar 88]	35
Dutch Minister on Fokker Financial Straits [ANP <i>NEWS BULLETIN</i> , 2 Feb 88]	35
Government Supervision [ANP <i>NEWS BULLETIN</i> , 3 Feb 88]	36
Italian Senate Approves Bill on Italian Space Agency [ANSA, 4 Feb 88]	36

#### BIOTECHNOLOGY

EC Fine Tunes Biotechnology Regulations, R&D Program	37
Results of EC Conference on Regulations [Maria Rosa Cattadori; <i>BIOTEC</i> , Nov-Dec 87]	37
R&D Program Revised	37
Italy, France Hold Biotechnology Meeting [BIOTEC, No 6, Nov-Dec 87]	38
State, CNR-Sponsored Biotechnology, Genetic Engineering Work in Italy	38
Biotechnology Projects Sponsored [Maria Rosa Cattadori; <i>BIOTEC</i> , May 87]	38
Conclusions of Genetic Engineering Project Presented [BIOTEC, No 6, Nov-Dec 87]	40
Overview of National Biotechnology Program [NOTIZIE <i>AIRI</i> , Oct 87]	40
BMFT Subsidies for Medical Biomaterials Research Announced [TECHNOLOGIE <i>NACHRICHTEN-MANAGEMENT INFORMATIONEN</i> , 15 Jan 88]	41

#### COMPUTERS

EC Issues Fourth Call For ESPRIT Bids [TECHNOLOGIE <i>NACHRICHTEN-MANAGEMENT INFORMATIONEN</i> , 15 Jan 88]	42
Trends in Optical Computer Research in France [Gilbert Rhemes; <i>ELECTRONIQUE INDUSTRIELLE</i> , 1 Feb 88]	44
Report Assesses State of French Supercomputer Technology [J.-P. Baranes; <i>ELECTRONIQUE ACTUALITES</i> , 12 Feb 88]	46

SCS 40 Supercomputer Tested at Ecole Polytechnique in France [Rene-Pierre Balme; ZERO UN INFORMATIQUE, 15 Feb 88]	47
--	----

## DEFENSE INDUSTRIES

France Develops Digital Sonar for Minesweeping [Pascale Lucius; INDUSTRIES ET TECHNIQUES, 2 Feb 88]	47
Augusta/Westland's EH 101 Makes Maiden Flight [TELEMATICA 2000, 14 Oct 87]	48

## LASERS, SENSORS, OPTICS

Prospects, Applications of Innovative Electrolumiscence Materials Systems Examined [Elio A. Savi Interview; INDUSTRIA OGGI, No 13, Jan-Feb 88]	48
BMFT Subsidizes Optical Laser Components Development [TECHNOLOGIE NACHRICHTEN-MANAGEMENT INFORMATIONEN, 15 Jan 88]	52

## MICROELECTRONICS

BMFT Plans Subsidies for Ion, Plasma Technology Projects [Siegfried Kaempfer; VDI NACHRICHTEN, 15 Jan 88]	53
Italian Engineers Develop 'Air Bridge Gate FET' [ELETTRONICA OGGI, Jan 88]	54

## NUCLEAR ENGINEERING

French Laue Langevin Institute Discovers New Isotopes [TECHNOLOGIE NACHRICHTEN-MANAGEMENT INFORMATIONEN, 29 Jan 88]	54
--	----

## SCIENCE & TECHNOLOGY POLICY

Italian Policymakers Meet to Discuss S&T Issues [NOTIZIE AIRI, Oct 87]	54
Belgium: Overview of Recent S&T Policies [NOTIZIE AIRI, Oct 87]	57
Great Britain: S&T Parks Listed [NOTIZIE AIRI, Oct 87]	58
ANVAR: 1987 Status Report, 1988 Objectives Detailed [AFP SCIENCES, 4 Feb 88]	60
Ciba-Geigy Diversifies in Biotech, New Materials [Caroline Verhack; L'USINE NOUVELLE, 11 Feb 88]	63
1988-91 Research Program, Budget of Karlsruhe Nuclear Research Center [TECHNOLOGIE NACHRICHTEN-MANAGEMENT INFORMATIONEN, 29 Jan 88]	64

## TECHNOLOGY TRANSFER

European Parliament Approves Research Programs, Italian Role Outlined [Giampiero Gramaglia; MEDIA DUEMILA, No 1, Jan 88]	65
Montedison to Head Consortium for Soviet Petrochemical 'Pole' [CHIMICA OGGI, No 12, Dec 87]	66
Text of Italy-Poland Automobile Agreement Reported [GAZZETTA UFFICIALE DELLA REPUBBLICA ITALIANA, 15 Jan 88]	67
CNET of France Develops 1-Micron CMOS, Flat Panel Technology	68
New Flat Panel Technology [D. Girault; ELECTRONIQUE ACTUALITES, 12 Feb 88]	68
CMOS Process Transferred to Matra Harris [D. Levy; ELECTRONIQUE ACTUALITES, 5 Feb 88]	69
France Opens First Part of 'RENAN' ISDN Network [INNOVATION TELECOM, Jan 88]	71

## EAST EUROPE

### ADVANCED MATERIALS

Poland Computerizes Calculation of Composite Material Properties [Dr K. Pucilowski; PRZEGLAD MECHANICZNY, No 16, 1987]	72
---	----

## COMPUTERS

- Hungary: Computer Industry in Serious Need of Imported Parts  
[Gabor Szeles Interview; FIGYELO, 28 Jan 88] ..... 77

## FACTORY AUTOMATION, ROBOTICS

- Overview of CNC Machining Center Production at Hungary's SZIM  
[Tibor Flanek; NEPSZAVA, 2 Feb 88] ..... 78

## MICROELECTRONICS

- Problems in Czech GaAs SDFL Circuit Design [SLABOPROUDY OBZOR, No 11, 1987] ..... 80

## ADVANCED MATERIALS

### French Standardization Efforts for Advanced Materials Testing Review

3698M226 Paris ENJEUX in French  
No 86, Dec 87 pp 32-36

[Article by Pierre Priester of AFNOR [French Association for Standardization]: "New Materials: Current Standardization Trends"]

[Text] Because of their position in the preliminary stages of industrial production, materials play a basic role in a great many industrial sectors.

Since the advent of plastic materials profound changes have occurred and industry is increasingly faced with a choice between traditional and new materials.

From an economic viewpoint, the studies on future prospects conducted by BIPE [Office of Information and Economic Forecasts] show that there will be a definite gap between the developments expected to take place in traditional materials and basic products (for example, raw steel, hollow glass, and cement) and the new materials sector (for example, composites, ceramics technologies, highly-elastic steels, and aluminum-lithium alloys). In the former sector, growth prospects are low or even nonexistent, while in the latter sector they are much more promising.

The establishment of standards for new materials can play an essential role by developing test-method standards for the definition of characteristics and behavior under certain conditions of use. Therefore, it would be interesting to make a preliminary, non-comprehensive survey of how the development of standards for new materials is progressing.

#### Composite Materials

The composite materials category covers a very vast area that includes composites with an organic, metallic, or ceramic matrix. However, up until now standards have been developed only for organic matrix composites, primarily on a country-by-country basis or internationally within the framework of the ISO [International Standards Organization]/TC 61/SC 13 subcommittee. This ISO subcommittee, which is involved in a broad range of activities, is divided into six working groups, two of which have French chairmen, emphasizing the dynamic, leading role played by the French in standardization. The existence of a European CEN/TC 66 technical committee working on reinforced plastics and composites should also be mentioned here. This committee is not currently active.

Before describing the standardization trends in this sector, the originality of the French approach should be emphasized. This approach, described in table 1, deliberately gives priority to standards for test procedures

rather than standards for materials. After formulating norms for terminology and identification, the French commission first tackled problems of sample selection and then dealt with test methods, all the while keeping in mind that the ultimate objective was to develop product standards or specifications. The status of standardization in France is shown in table 2; the work done covers both carbon-fiber and fiberglass composites. However, this list requires three observations:

- no standards have yet been published for aramide fibers;
- standards for resins are not included in the list of activities;
- all the standards mentioned are for test methods.

Because of the dynamic nature of the French standardization sector, interaction between the research being done in France and that done by the ISO is common. This is particularly true of fiberglass standards. First developed in France, these standards were used as a basis for the formulation of international standards, and were subsequently revised in France in order to incorporate the improvements introduced at international level. At present, test procedure standards can be considered to be well established both in France and at international level.

The compilation of French standards for fiberglass impregnated materials is an original work and ISO research has once again depended heavily on the French studies. The French standards are currently being revised in order to integrate the specifications for carbon-fiber materials, and research for the three standards NF T 57-601, 602, and 608 is now complete.

The cooperative agreement between the FRG and France can be considered the most important catalyst in the formulation of standards for composite materials in recent years. Realizing that their standardization policies were complementary, 18 months ago these two countries—the FRG with its performance standards and France with its test standards—decided to work jointly on the development of standards. The agreement, which originally concerned carbon fibers, is now to be extended to fiberglass and aramide fibers.

This extension is due to the fact that the FRG does a great deal of work on aramide fibers, which are not produced in France, and is eager to study French fiberglass standards.

#### Structural Adhesives

The growing demand from the transportation sector—automobiles, high-speed trains, aircraft, and now space exploration—has led to major developments in the area of structural adhesives. This means that not only must research and development be done to improve the quality of resins, but that a substantial work also has to be made to define the characteristics of bonded joints.

It is generally admitted that the performance of bonded joints in a given environment essentially depends on three parameters; these are:

- the adhesion between the adhesive and the supports;
- the cohesion of the adhesive after hardening;
- the geometry of the joint.

Clearly the formulation of standards began with these basic points and France has played a key role in this area, where the standards were often used as a basic reference point in ISO research within the framework of the work of the ISO/TC 61/ SC11/GT 5 "Polymer Adhesives" subcommittee. On the other hand, at the moment, unfortunately, no European standards for structural adhesives exist.

The first AFNOR standards for adhesives were drawn up in 1972. Since work began, efforts have focused on product classification and terminology (NF [French Standard] T 76-001 and NF T 76-001 standards). In parallel with this basic work, the commission's efforts have centered around methods for defining the characteristics of adhesives. This research took concrete form between 1981 and 1984 with the publication of a number of standards concerning tests for peeling, shearing, splitting, tensile strength, stress resistance, shock resistance, etc. These standards are revised regularly because test equipment must be updated constantly.

Along with this series of standards, the NF T 76-130 standard developed in 1984 is of great interest, not only because it makes an inventory of the main types of fractures that can occur with bonded assemblies but also because it attempts to develop a unified terminology (table 3).

Work on standardization currently focuses on the behavior of adhesives when subjected to a clearly defined stress (twisting or shearing). The objective is to supply the basic information on the adhesive that can be used by the research department to calculate the geometry of bonded joints.

#### Technical Ceramics

All the preliminary studies point to substantial development in technical ceramics, for which the three markets are:

- thermomechanical applications;
- electronics;
- cutting tools.

At present, standards are only being developed at national level, and standardization programs are currently being implemented in the major industrialized countries. For this reason, there is still no ISO or European research devoted to technical ceramics. However, the advisability of conducting standardization research at European level is being examined.

In France, there is an agreement that regulates research on standards for ceramics used in thermomechanical applications. This agreement covers:

- analysis of the elements (principal elements and impurities);
- testing of the physical, mechanical, and thermal characteristics of finished products.

A second agreement concerning ceramics for electronic applications will be ready very soon.

Table 4, which is not to be considered comprehensive, gives an idea of the work currently in progress in various countries, emphasizing:

- the marked orientation of research toward thermomechanical applications, primarily in the form of test methods for physical, mechanical, and thermal characteristics;
- the importance of the Japanese effort;
- the existence of a joint U.S.-FRG-Sweden research program devoted to the definition of the characteristics of powders (silicon nitride, and silicon, silica, and zirconium carbides) and the behavior of parts made from these powders to 3- and 4-point bending test.

This research program is complementary to the ASTM [American Society for Testing and Materials] program.

#### Metallic Materials

The compilation of standards, whether for ferrous or non-ferrous metals, can be considered to be almost complete because the range of test method standards (destructive, non-destructive, chemical analysis, etc.) often proves adequate for definition of the characteristics of a new material. Because of this, the emergence of a new alloy does not necessarily require compilation of a set of standards above and beyond the development of product standards.

#### Ferrous Metals

Standards are compiled at three levels: at ISO level (within the framework of the TC 17 chaired by the Japanese); at European level; and at country level. A salient point was the development of European steel standards. This work, which was started approximately 25 years ago within the CECA [European Coal and Steel Commission] framework, led to the development of approximately 170 Euronorms which, like the ISO standards, placed no constraints on the development of national standards. However, these Euronorms had the effect of bringing the ideas and products of the various European steel industries closer together, and have been used as reference documents for international negotiations. Since 1 January 1987, following a change in the statutes, European steel product standards are established within the framework of the ECISS (European Committee Iron and Steel Standardization), which is

connected with the CEN [European Standardization Committee]. Independently of the development of new standards, the Euronorms will gradually be transformed into European norms (EN) that European countries (EC plus EFTA [European Free Trade Association]) will be obliged to adopt as national standards.

Within the ECISS program, three standardization projects concerning new materials should be completed soon; these are:

- Pr EN 10002/Part 1: metallic materials—tensile strength—test procedure;
- Pr EN 10170: cold-processed electrolytic chromium-iron alloy;
- Pr EN: cold-processed electrolytic tin; (Footnote 1) (The number for this standard will be established shortly.)

The standardization of tensile strength tests covers all metallic materials and all types of products (long, flat, and hollow). However, for certain special metallic materials and certain special applications, specific standards or special conditions can be developed for tensile strength tests.

The standardization programs for tin and chromium-iron alloys are indicative of the trend away from using tin (decrease in the minimum thickness of tin, the possible replacement of tin with chromium-iron alloy) and the technological advances in these materials (particularly a reduction in thickness).

France played an important role in these three programs, chairing the tensile-strength test group and making a major technological contribution (tin and chromium-iron alloy).

In France, the standardization program has become more selective as a result of the work done by the ECISS. For the past few years, highly-elastic steels have been incorporated in a certain number of French standards (NF A 36-201-202-203, NF A 36-210, NF A 36-603), demonstrating the important role that the French steel industry attributes to these steels. These standards are revised periodically in order to take account of technological progress, or are supplemented with new standards such as the NF A 33-111 standard entitled "Dispersoid Steels Used in Heat Forging—Semifinished Products and Bars."

In connection with test methods, a special effort has been made in fracture mechanics, an important area for aeronautical and nuclear applications. Four documents were published recently:

- NF A 03-180 (June 1982): Fracture Mechanics—The Intensity Factor of Critical Stress;
- A 03-181 (June 1987): Fracture Mechanics—Determination of the Fracture Energy on Zero Checks (ECO) (experimental standard);

- A 03-182 (June 1987): Fracture Mechanics—Determination of the Gap at the Bottom of a Fissure (experimental standard);
- A 03-183 (June 1987): Fracture Mechanics—Determination of the J Integral (experimental standards).

These standards soon will be supplemented by publication of an information booklet on ECO testing.

### Non-ferrous Materials

Although there is a wide range of non-ferrous metals, only the cases of aluminum and copper will be considered here. For these two metals, standards are developed at two levels: ISO level (for aluminum within the TC 79 framework under French chairmanship, and for copper within the TC 26 framework under FRG chairmanship).

France is playing a leading role in developing international aluminum standards; but no initiatives concerning new materials exist either in France or at international level.

For copper, there are currently some French initiatives involving form-memory alloys or alloys for connections.

### Cast Metallic Alloys

A guide is currently being prepared in France. Scheduled to come out in 1989, it concerns both cast metallic alloys, for which standards have already been developed, and alloys currently being developed, such as:

- slightly alloyed lamellar graphite or spheroidal graphite cast iron;
- silicon or chromium-ferritic cast iron;
- superalloys.

The objective is to help both those who establish specifications and those who place orders to design an item and define a set of rules for that item. Within this framework, the following aspects will be dealt with:

- the different ways of producing cast products;
- criteria for use and the dominant properties of various types of cast iron and cast alloys (aluminum, copper, magnesium, steels, etc.).

### VAMAS Or Pre-Standardization for New Materials

In 1982, during the Versailles meeting of the heads of state of industrialized countries, France proposed to its allies a cooperative program to be called "Growth, Technology, and Employment" covering areas related to advanced technologies.

Eighteen topics, including VAMAS (Versailles Advanced Materials And Standards), were accepted. Shortly after, a memorandum was signed by all participating countries, and VAMAS was given autonomous status.



1)	Vocabulaire - Désignation
2)	Échantillonnage
3)	Méthode d'essais
4)	Bases de spécifications
5)	Spécifications

Table 1—[French Approach to Standardization]

Key:

1. Terminology—designation
2. Sample selection
3. Testing procedure
4. Criteria for specifications
5. Specifications

The aim of VAMAS is to carry out pre-standardization work in new materials. Seven countries (the United States, Canada, Japan, Britain, the FRG, Italy, and France) and the EC are taking part in VAMAS. The chairmanship alternates between Britain and the United States.

Thirteen areas for study were established (table 5). Ceramics and organic composites are being handled by France. However, France is also active in most of the other areas.

A reading of the table shows that the areas selected are not limited to methods for defining the characteristics of materials, but also include diffusive technologies such as soldering and surface analysis as well as data banks.

The "recommendations" or "pre-standards" developed within the VAMAS framework will not be sent directly to the ISO, but submitted to the bodies responsible for standardization in individual countries.

Conclusion

This overview, although far from complete, shows the importance of the role of standardization as a development tool for new materials. Moreover, in future years it will become increasingly necessary to take the following factors into account:

- standardization is not only an activity to be carried out on a country basis, but a European and international activity. More and more, Europe is becoming the focal point for work on standardization;
- because of the acceleration of the rate of technological change, standardization must develop in parallel with these changes and not simply place its seal on established practice. This will mean a new relationship between industry and standardization;
- the emergence of new materials, the growing choice of materials available for certain applications and their use in increasingly specialized conditions, the importance of diffusive technologies and the development of data banks must be taken into consideration in the development of standards.

These initiatives will only be successful if there is extensive cooperation between AFNOR and industrial partners, aimed at defining and establishing a strategy for standardization.

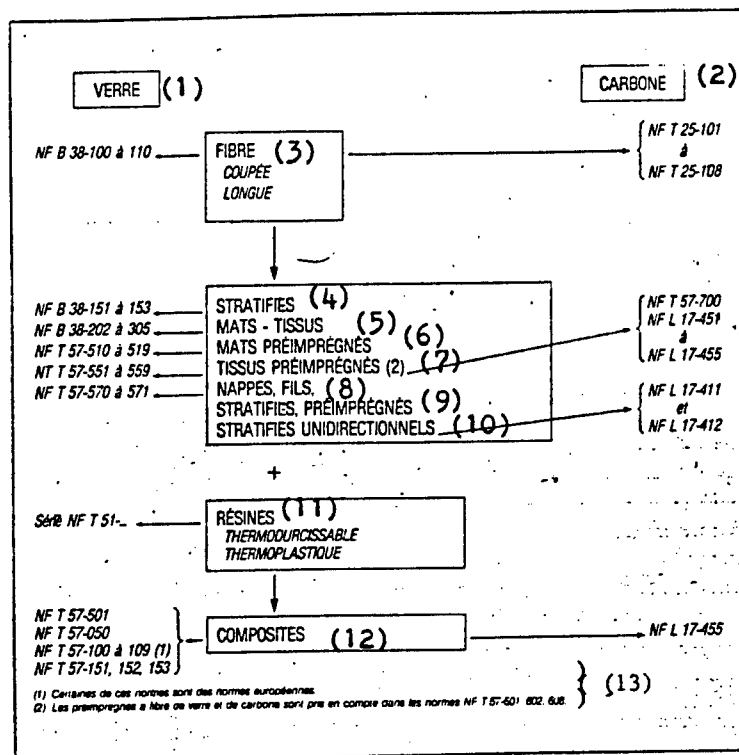
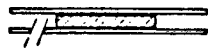


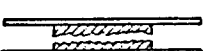
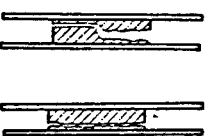
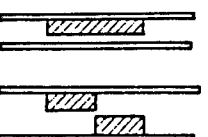



Table 2—[Review of French Standardization Activities]

Key:

1. Glass
2. Carbon
3. Fiber
  - Cut
  - Long
4. Laminates
5. Mats, fabrics
6. Preimpregnated fabrics
7. Preimpregnated fabrics
8. Layers, threads
9. Preimpregnated laminates (2)
10. Unidirectional laminates
11. Resins
  - Thermohardened
  - Thermoplastic
12. Composites
13. (1) Some of these standards are European standards.  
(2) Materials preimpregnated with glass and carbon fibers are not included in NF T 57-601, 602, 608 standards.

4<sup>(1)</sup> DÉSIGNATION - DESCRIPTION SCHEMATIQUE DE DIFFÉRENTS FACIÈS DE RUPTURE DES ASSEMBLAGES COLLÉS

Faciès de ruptures (1)	Désignations (2) (voir note 2)
 <p>Rupture de l'un ou des deux supports (3)</p>	RS
 <p>Rupture d'un support par délaminage (4)</p>	RSD
 <p>Rupture par arrachement du revêtement (1) d'un support (5)</p>	RR (voir note 1)
 <p>Rupture de cohésion (6)</p>	RC
 <p>Ruptures de cohésion superficielles (7)</p>	RCS
 <p>Ruptures d'adhésion (8)</p>	RA
 <p>Rupture de cohésion avec pelage (9)</p>	RCP

(1) Revêtement d'un support : tel que peinture, primaire, phosphatation, vernis... (10)

Table 3—Schematic Identification and Description of the Different Types of Fractures in Bonded Materials  
(Excerpt from NF T 76-130)

Table 4—Ceramics

1983-88 Based on a public inquiry in 1987 Underway since 1985 USA + FRG ASTM program

Sample selection		x	
Tensile strength	x		
Tenacity	x		x
Poisson coefficient	x		x
Compression strength	x		
Bending strength			x
Folding strength	x		
Elasticity module	x		x
Deformation under light pressure		x	
Presence of cracks		x	
Volume mass and porosity		x	x
Resistance to oxidation	x		
Resistance to corrosion	x		
Resistance to fluid stress	x		
Heat conductivity	x	x	
Specific heat	x		
Elasticity module at T degrees	x		
Folding strength at T degrees	x		

Table 5—[VAMAS Topics]

Topics	Lead Country	Lines of Research
Wear-testing procedures	FRG	Testing conditions/interlaboratory testing
Chemical analysis of surfaces (Auger)	USA	Procedures/model development
Ceramics	F	Durability/hardness/heat-shock resistance
Mixed polymers	C	Behavior under static and dynamic load
Organic composites	F	Delamination/durability/CND
Cryogenic materials	J	Electric current under high field/Tensile test at 4 degrees K
Biomaterials	I	Synthetic hydroxyapatite/behavior under friction and wear
Heat corrosion	GB	NaCl, s, 1,000 degrees C/interlaboratory testing
Soldering characteristics	GB	Fluctuation of TIG penetrations
Data banks	USA/EC	Inventory of activities, research projects
Formation of cracks under fluid stress	GB	ASTM plus EGF plus French programs
Polymer durability	GB	Inventory of accelerated test procedures, correlation among parameters
Oligocyclic fatigue	EC	Influence of experimental parameters

## **CISE-FIAR Claims European Leadership in GaAs Cell Production**

*3898M175 Milan ALTA FREQUENZA in Italian  
No 5, Jul 87 pp 73-88*

[Article by L. Bertotti, C. Flores, and P. Paletta of CISE [Center for Information Studies and Experience] S.p.A., Milan and M. Martella of FIAR S.p.A., Milan: "Gallium Arsenide Solar Cells for Space Applications"]

[Excerpts]

### **1. Introduction**

The massive development of the space sector over the last few years has greatly increased power requirements on board satellites. Moreover, it is expected that, with the advent of more flexible and less costly orbit launching systems such as the Shuttle and Ariane, this requirement for electricity will grow even more. The 1-3 kW generators currently in use will be replaced by generators that will provide the several dozen kW needed, for example, for permanent orbiting stations. Various approaches to this problem are currently being examined. With the exclusion of nuclear generators because of their weight and the security problems they involve, at least for missions in the earth's orbit, the greater part of the work being done today is aimed at improving the silicon-cell photovoltaic generators currently in use and at developing new photovoltaic components with characteristics of high efficiency, reduced weight, and greater resistance to radiation.

Of all innovative photovoltaic elements, gallium arsenide (GaAs) solar cells appear to have the greatest potential for these future applications. Because of the characteristics of the semiconductor, GaAs cells have a number of advantages over Si [silicon] cells, namely:

- greater efficiency;
- greater resistance to radiation;
- very little dependence on temperature efficiency;
- efficiency not dependent on thickness;
- the possibility of operating with high light flows;
- recovery from 150-Curie radiation damage.

On the other hand, the principal problems of these cells compared with Si cells are:

- cost of materials;
- greater density;
- a production technology that is not yet appropriate for space.

Table 1 compares the characteristics of commercial silicon cells against those of GaAs cells.

Various types of GaAs cells have been studied and tested over the last 15 years in many research laboratories. Laboratory findings have shown that this technology is now mature. Several industrial initiatives are currently underway for mass production of these components.

This article briefly describes the operating principles of GaAs solar cells, their properties, and their production technologies. The impact of these new devices on systems is also analyzed. The last part of the article describes the main in-flight experiments and the potential for development over the next few years.

### **4. Type-Approval of Solar Cells for Use in Space**

A comparison of GaAs and Si cells makes it clear that the former are suitable for use in space, while the greater technological development of Si solar cell arrays has meant that so far they have been mounted on all satellites, the growing interest in GaAs cells and their applications appears to be a natural development. In order to use GaAs cells on a large scale in space, they must undergo a series of tests to establish and ensure their survival in the space environment. This set of tests constitutes the so-called type-approval program, which establishes the required characteristics of the product once producers and users have defined and accepted the program. For this reason CISE, together with FIAR, proposed a specific type-approval program for GaAs cells (based on an official ESA [European Space Agency] document, PSS/01/604, which is usually used as a reference for silicon cells) to ESA with the following objectives:

- 1—to establish the environmental and life tests that the cells must undergo;
- 2—to establish the correct order of the test sequences;
- 3—to establish the type-approval requirements for manufactured GaAs cells.

The following aspects were examined:

- definition of the number of cells to be tested;
- definition of an acceptable number of breakdowns following each test sequence;
- test conditions and specifications.

The type-approval program was established on the basis of the large number of environmental tests listed below:

- thermal stress;
- electron irradiation;
- proton irradiation;
- photon irradiation;
- boiling water;
- humidity;
- high temperature in a vacuum;
- rip test.

Each of these tests has its own acceptance criterion correlated as necessary with the physical properties of the cell and its production technology.

The correct order of the tests is then incorporated in a type-approval program containing the organized test sequence that the groups of cells must undergo. In this case, the program is divided into seven areas, each of which has a specific significance and objective. Table 2 gives an overview of this program.

The irradiation tests are extremely important for use of the cells in space. These tests are generally difficult to conduct because they require equipment that is normally not available in laboratories.

The graphs in figure 9 show the decline in cell efficiency following irradiation with flows of 1-MeV electrons ranging from  $3 \times 10^{14}$  e/cm<sup>2</sup> to  $7 \times 10^{15}$  e/cm<sup>2</sup>. These would be the equivalent of 5 or more years of cell exposure to space conditions.

Figure 9 illustrates the data for GaAs cells produced by CISE and other manufacturers as well as for Si cells produced by Hughes.

It can be seen that at maximum irradiation levels, the initial efficiency of the device may be reduced by 50 percent. This is the reason for the major commitment to the identification of optimized structures with a high resistance to space conditions.

The subject of proton irradiation is more complex, for the following reasons:

- the test is extremely costly;
- very few laboratories in the world are equipped to conduct it;
- up until now, ESA has not considered it necessary to include this test in the Si cell type-approval program.

However, it would seem that the problem of this type-approval test could be overcome to some extent by using the concept of equivalent flux. Given that by flux we mean the number of particles of any type passing through a given surface over a given time period (expressed in particles per square centimeter), we can analyze the concept of equivalent flux.

The objective of this concept is to correlate the effects of radiation from various particles on the solar cells. Thus, the damage produced by electrons with various energy levels is correlated with the damage produced by 1-MeV electrons using the electron damage coefficient. The damage produced by protons with various energy levels is correlated with the damage produced by 10-MeV protons using the proton damage coefficient. The damage produced by 1-MeV electrons is correlated with the damage produced by 10-MeV protons using the combined proton-electron damage coefficient.

In practice, this means evaluating the fact that it is normally 1-MeV electrons that strike the surface of cells. The resulting damage can then be expressed by using a coefficient linking the power output after irradiation to the power output before irradiation.

$$Rp(Fp(Ep)) = Re(Fe)$$

where: Rp = the response function of the device to the damage produced by protons; Fp = the proton flux; Ep = the proton energy; Re = the response function of the device to the damage produced by electrons; Fe = the equivalent electron flux (electron energy is not stated explicitly, we should point out, because the fixed value of 1 MeV is used).

Figure 10 shows the relationship between the degradation of maximum power in a GaAs solar cell and the type of charged particle.

## 5. Areas of Application

Photovoltaic generators are currently the principal source of electricity for the various types of satellite.

Other forms of electricity generation, such as nuclear or thermodynamic generators, have been suggested to deal with the increasing need for power. However, photovoltaic generators will continue to play a leading role for a long time, because problems such as security in the generation of nuclear energy, or weight in the case of thermodynamic generation, are apparently difficult to overcome.

Satellites can be divided into categories based on the type of application (a), the type of stabilization (b), and the operational orbit (c).

The applications include the following:

- commercial satellites (CO) used for telecommunications and radio and television broadcasting (for example, Arabsat and Intelsat);
- earth-observation satellites (EO, for example, ERS1 and Landsat);
- meteorological satellites (ME, for example, Meteosat and NOAA);
- military satellites.

The types of stabilization ordinarily used are:

- stabilization on three axes (3X);
- spinned (S).

Satellites stabilized on three axes have solar generators consisting of planar arrays that are constantly directed toward the sun, while spinned satellites are generally cylindrical and orbit with a rotary movement around their own axis. In this case, the photovoltaic generator covers the body of the satellite completely.

The most widely used operational orbits include the following:

- the geosynchronous orbit (GEO), at an altitude of 36,000 km;
- the low earth orbit (LEO), at an altitude of 500 km.

Commercial satellites use the GEO orbit, while earth-observation satellites and the majority of scientific research satellites use the low orbit. Depending on requirements, military satellites use either the low/medium or the geosynchronous orbit.

The space station project deserves a separate mention. This goes beyond the concept of the traditional satellite to become a permanent orbiting operations center, capable of expanding in modular segments and of housing human beings.

The space station is the project with the greatest power requirements over the next 10 years.

To give a brief idea of the whole range of space programs, table 3 provides a list of several missions either recently conducted, currently underway, or scheduled for the near future. The objective of the mission, the type of stabilization, and the power installed are shown.

Inquiries into the range of space applications currently available and projections about future missions clearly indicate certain requirements which, if they are to be satisfied, will necessitate the development and improvement of new technologies for all the components of the generator system. This is especially true of the solar cell, which is the primary device in this system.

These requirements can be summed up as follows:

#### a) High Power Available at All Times

This requirement is easily explained if we consider that the short- to medium-term (1985-95) requirements for power on board space vehicles are estimated at between 2 and 30 kW at the beginning of life (BOL), and are expected to increase to 100 kW within the year 2000. Moreover, the long operating times envisaged for each mission (average 5-10 years) make it necessary to ensure a high power output even at the end of life (EOL).

#### b) High Power/Weight Ratio

The need for a high power/weight ratio derives from the very high launching costs per unit of mass of the space vehicle and from the size limitations relating to the launchers currently available, such as the Space Shuttle and Ariane.

#### c) The Possibility of Operating Reliably for Long Periods in Various Orbit Conditions

An operating time of 3 to 5 years is required for meteorological satellites in geosynchronous orbit, and of 7 to 10 years for telecommunications and radio/television broadcast satellites.

Operating times in low earth orbits are generally between 2 and 5 years for earth-observation satellites and 10 years for space stations.

Each of the orbits described above has specific environmental conditions that strongly influence the power output of solar arrays. Table 4 shows the most important environmental effects in LEO and GEO orbits and their impact on solar generators.

The physical characteristics of gallium arsenide solar cells discussed in the introduction make them devices that are highly competitive with silicon cells and are capable of satisfying many of these requirements. In fact, the high conversion efficiency makes it possible to use generators with a smaller area (in the case of satellites with 3-axis stabilization), and means that expandable cylindrical surfaces (in the case of spinned satellites) are no longer required. The high resistance to radiation and the limited temperature coefficient make it possible to conduct missions with a long operational life.

As an example, we give below some of the results of a study conducted by FIAR in cooperation with CISE within the framework of the Pilot Line program.

The study concerned the SAX satellite (3-X satellite for scientific research operating in a low earth orbit for 2 years). Given the type of orbit (LEO), the power required (1.5 kW), the operating temperature (80 degrees), the fluence, the array geometry (rigid with two identical wings), and the mass budget, the size of the solar generator was determined using GaAs cells instead of silicon cells.

The results are summarized as follows:

- a sizeable reduction in the area of the solar array (30-35 percent);
- a reduction in total mass (5-25 percent);
- a sizeable reduction in the inertia periods of the wings, and a consequent reduction in fuel consumption for position control;
- a reduction in aerodynamic drag.

#### 6. Principal In-Flight Tests

Up to now, no space mission has relied on GaAs technology for electricity generation. However, certain in-flight trials with GaAs cells, either already conducted or scheduled for the immediate future, demonstrate the progressive acquisition of knowledge concerning the device and the integration methods peculiar to this

component; this knowledge was inherited only partially from silicon cell technology because of the different mechanical and electrical characteristics of GaAs.

Let us take a brief look at some space missions on which GaAs solar cells either have been or will be used.

#### **Lunokhod I - Lunokhod II/USSR**

The Lunokhods are space vehicles designed to operate on the surface of the moon. GaAs, rather than silicon solar cells, were chosen as the primary energy source because of their ability to operate at high temperatures while conserving a high photovoltaic efficiency.

Lunokhod I's solar generators, which reached the moon on 17 November 1970, operated successfully for 10 lunar days, until 4 October 1971.

The test was repeated on board the Lunokhod II, which reached the moon on 16 January 1973. The solar generator with GaAs cells operated for 5 lunar days, that is, for the duration of the program, maintaining its electrophysical properties almost intact.

#### **Venera/USSR**

In the course of this mission, tests were done to compare the optical and electric characteristics of silicon solar cells against those of GaAs solar cells, with the aim of acquiring reference standards for laboratory calibration and characterization using solar simulators.

#### **CS-3 (Communication Satellite)/Japan**

CS-3 is a national telecommunications satellite to be launched in 1988 by the Japanese H-1 rocket. This will be the first time that a commercial satellite (the CS-3 is of the spin-stabilized type) will obtain its energy entirely from GaAs solar panels. Contrary to the cases described earlier, the GaAs solar cells will not be used experimentally, but will be fully inserted in a vital subsystem of the satellite, completely replacing the silicon components.

In this case also the choice of GaAs was determined by the need for greater primary power on board to back up numerous transponders, while still limiting the area occupied by solar arrays. In fact, an increase in this area in spinned satellites necessitates a rather costly and complex mechanism involving the telescopic expansion of the primary drum, which reduces the reliability of in-flight operations.

CS-3 uses design criteria already used for a previous mission (CS-2), but the available power supply will be double that of the CS-2 and the operational life will be 7 years as opposed to 5 years.

To compensate for the heavier weight of the solar cells chosen, very light structural materials (carbon fiber and kevlar) and light electronics were used. The project was based on integrated circuits and monolithic integrated circuits.

#### **SCCE (Solar Cell Calibration Experiment)/ESA-NASA**

CISE took part in the SCCE calibration experiment, supplying ESA with two gallium arsenide cells developed in its own laboratories. The cells were used on the STS 07 and the STS 11 missions.

The objective of the experiment conducted on board the Space Shuttle was to generate reference standards to be used in laboratory measurements with solar simulators. In fact, light conditions outside the atmosphere are difficult to reproduce with simulators; only a well calibrated reference gives precise correction of the parameters measured on other cells.

#### **ASGA (Advanced Solar Gallium Arsenide Array)/Italy**

The ASGA experiment involves a solar panel consisting of two halves on which advanced gallium arsenide solar cells will be mounted; this will fly onboard the EURECA-1 satellite in 1991.

In the course of the mission, which will last 6 months, the electric parameters (voltage/current curve) and the temperature values for the various strings of cells will be recorded by specially developed electronic equipment in order to verify behavior in environmental conditions typical of low orbits.

The strings of cells mounted on the panel will be diversified on the basis of various parameters such as the type of cell (heterostructure, concentration cell, or thin cell), the thickness of the junction (thin junction or thick junction), and last, the thickness of the protective glass covers (50, 125, and 500 micrometers).

In particular, the concentration cells will be mounted on Cassegrainian optical concentrators specially developed for ASGA. The concentrators have a light-concentration factor of 10 suns.

This is the first time in Europe that in-flight testing of gallium arsenide solar cells will be conducted during a mission that is extremely interesting in two respects; these are:

- the length of the mission: 6 months of operation is a sufficient period of time for a meaningful evaluation of the behavior of the cells;
- the type of orbit: EURECA operates in the orbit typical of future space stations, for which—as we have already seen—gallium arsenide is expected to be a promising solution.



Figures 12 and 13 show the general layouts of the panels with planar cells [12] and of the panel with concentration cells [13].

## 7. Industrial Production of GaAs Photocells

The 1980's witnessed a growing world interest from firms eager to acquire the technology necessary to produce GaAs photocells for space applications and to install pilot production lines.

There are many laboratories engaged at various levels in the development of the component, as well as its optimization, the study of structures and types of new cells, the improvement of trimming technologies, and the integration of cells in modules; therefore, we would like to analyze the true scenario in which the various competitor countries are operating.

### Japan

In Japan, photovoltaic production technology was first developed by Sharp and later implemented and consolidated at an industrial level by MELCO (Mitsubishi Electric Corporation) following the decisions made by NASDA, the Japanese Space Agency.

MELCO installed a production line with the following characteristics:

- production capacity of 50,000 cells/year;
- type of cell: flat GaAs; thickness 300 micrometers; 2x2 sq. cm. or 2x4 sq. cm. in size;
- growth technology: LPE [Liquid Phase Epitaxy];
- devices already produced (1986): 60,000-70,000 cells.

MELCO activity started and grew because of the active interest demonstrated by NASDA with its decision to use the cells produced by MELCO's line on the two CS-3a and CS-3b Japanese satellites scheduled for launching in 1988, as well as the specific type-approval program subsequently drawn up by NASDA.

At present MELCO is able to sell type-approved solar cells on the international market at a price of about \$100 for a 2x4-cm<sup>2</sup> cell, ready to be welded or soldered to interconnectors.

### Europe

In Europe, the ESA manages and coordinates the space activities of the various countries involved in the flight programs. Up until now, the ESA has had no involvement in flight programs where on-board energy is either entirely or partially supplied by GaAs cells. However, the ESA supports several research programs designed to increase knowledge of GaAs technology and to make it possible to produce high-efficiency devices with structures that are optimized for space applications.

Below we give a list of current activity in the various European countries based on the information available.

**France:** The Matra Espace company has purchased from the CNES (National Center for Space Studies) technology to produce solar cells using a laboratory MOCVD [Metal Oxide Chemical Vapor Deposition] growth plant. The objective is to have a small production line with an annual capacity of approximately 100 concentration cells destined primarily for military uses.

**UK:** The Marconi firm has a program underway to develop GaAs space solar cells for use with light concentrators. While the details of this program are not well known, it appears to be oriented primarily toward military applications.

**FRG:** The AEG and MBB firms are involved in GaAs programs. Specifically, AEG received funds in 1987 from the ESA to study trimming and module integration technologies, while MBB is now involved in a cooperative program with MELCO of Japan oriented along the same lines.

**Italy:** Italy would appear to be in a privileged position in Europe because, taking advantage of existing know-how developed by CISE in the 1975-85 period, it launched an initiative financed by the PSN-CNR [National Space Program-National Research Council] and conducted by CISE and FIAR that should lead to the installation within the next 3 years of a pilot production line capable of producing more than 10,000 GaAs cells a year. If it manages to maintain its current leadership in Europe, Italy could become the third largest cell producer in the world within approximately 3 years. This is all the more probable if the ESA believes—as it did in the case of silicon cells—that the size of the European market can justify only one country producing GaAs cells.

## 8. Development Prospects for GaAs Cells

As mentioned in the previous paragraphs, GaAs solar cells for space applications have recently reached a substantial degree of maturity. Production lines have been installed and the first satellites powered entirely by these cells are being built. Some of the problems inherent in this technology, such as the high cost and cell weight, still have to be solved. For GaAs cells, this means problems of competitiveness with the silicon technology currently being used. To overcome these problems, studies and research are being conducted with the aim of, first, substantially increasing conversion efficiency to make the current difference with silicon much more pronounced and second, to reduce the impact of the weight of GaAs in solar panels.

The approach being used to address the cost-reduction problem involves the substitution of traditional LPE technology with a more flexible and more productive technology such as MOCVD.

To obtain a new generation of GaAs cells that will be more competitive with silicon, at least three different configurations are currently being studied: multijunction cells, thin cells, and concentration cells. Below we give a brief description of the various technologies.

### Multijunction Cells

Multijunction cells are obtained (Figure 14) by placing active photovoltaic p-n junctions in optical series with increasing band gaps, so that the radiation not absorbed by a cell is transmitted to the next one. This structure makes it possible to use the electromagnetic energy distributed in the solar spectrum more efficiently and thus gives greater overall conversion efficiency. Various configurations can be used to produce multijunction cells: stacked or monolithic cells; and cells operating either in series or independently. The best compromise offered by current technology is offered by the combination of two mechanically stacked cells operating in 4-terminal configurations and thus electrically independent.

CISE in particular recently produced stacked multijunctions joining a GaAs cell to an Si cell. The advantages offered by this coupling can be summarized as follows:

- the problem of current coupling does not arise because the devices making up the multijunction operate independently;
- the development and production of the two components are done separately;
- both the materials used—GaAs and Si—are well known and the production technologies can be considered mature.

The multijunctions produced were manufactured starting from an Si cell 180 micrometers thick of the BSFR type, and from a 200 micrometers thick GaAs cell with an area of 4 cm<sup>2</sup>. Table 5 shows the performance measured in laboratories of three samples of multijunction cells, characterized by an AMO (135 mW/cm<sup>2</sup>) solar simulator. The efficiencies measured were greater than 19 percent and there are firm possibilities of achieving efficiencies of approximately 20-21 percent, with interesting prospects for future applications.

### Thin Cells

It is well known that because GaAs is a direct-gap material, all incident radiation is absorbed within a few micrometers of material below the surface exposed to radiation.

For this reason, it is theoretically possible to build thin solar cells up to 10 micrometers thick with no appreciable loss of energy production. Several laboratories are searching for a technology that will make it possible, once the active layers have grown, to thin out or remove the substrate from the zone in the device used for photogeneration.

Among the various approaches, CLEFT (Cleavage of Lateral Epitaxial Film for Transfer) technology deserves mention. In this technology the substrate can be separated from the epitaxial layers and re-used for growth processes, thereby reducing the cost of the substrate in the overall cell cost.

The basic principle of the CLEFT process is shown in Figure 15. Although the technology certainly cannot be considered consolidated, small devices (0.5 sq. cm.) have been produced with efficiencies of 15-percent AMO and a thickness of approximately 10 micrometers.

A simpler technique for producing thin cells consists in thinning out the GaAs substrate through a chemical process. It is possible to achieve thicknesses of approximately 100 micrometers in this case. This represents a satisfactory weight reduction compared to traditional cells (more than 300 micrometers thick). In addition, as opposed to cells produced with the CLEFT system, the device obtained can be manipulated directly without any backup support.

Figure 16 shows the current/voltage curve for a CISE cell with a thickness of 100 micrometers.

### Concentration Cells

A third technique being studied to solve some of the problems relating to use of GaAs is a technology in which solar radiation is concentrated on solar cells using appropriate optical systems. In this way, two immediate effects are obtained. First, the surface of the solar panel covered by cells is reduced by a term equal to the concentration ratio. Second, the conversion efficiency of the cells increases with the increase in photo-generated current because of the effect of the concentration of solar rays, and consequently there is an increase in open circuit voltage (see equation (7), paragraph 2). However, the advantage of using concentrators in space is related to the theory that their cost and weight per surface unit are lower than those of solar cells. An additional advantage is the fact that the optical concentrator acts as a screen against ionizing radiation.

CISE has been active in the field of light concentration and the development of solar cells related to this technology for a number of years, particularly for the production of photovoltaic energy for use on earth. On the basis of this experience, research has been done on GaAs solar cells to be used with light concentrators of up to 100 suns for space applications. The critical point in the construction of a high-concentration solar cell is the size of the contact grid, which has to be capable of minimizing serial resistance.

Figure 17 [not shown] shows a group of cells specifically developed for the ASGA project (see paragraph 6) with AMO conversion efficiency at 100 suns of more than 17 percent.

## Conclusions

In the next few years, gallium arsenide solar cells will represent the new generation of photovoltaic generators for space use. They will be able to meet the increased electricity requirements on-board future space vehicles because of their high conversion efficiency and resistance to environmental factors. The production technology of these cells has completed the research phase and is already being applied in industrial production pilot lines.

Some satellites, wholly powered by GaAs photocells, are soon to be put into orbit, and several scientific experiments to evaluate this new technology are currently

underway. At present, Italy has the greatest know-how in Europe concerning this type of technology. In fact, the first phase of research supported by the CNR's National Space Program to develop a pilot production line for GaAs photocells has just been completed at CISE and FIAR.

GaAs solar cells type-approved for use in space are already available in small quantities, and it is expected that industrial production on a scale capable of satisfying the needs of Italian and European satellites should begin within the next 2 years.

Type of material	Si-BSF	Si-BSFR	Si-BLACK	GaAs	GaAs	GaAs
Manufacturer	Sharp	Sharp	Sharp	MEI.CO	Spectrolab	CISE/FIAR
Area (cm <sup>2</sup> )	4	4	4	4	4	4
Thickness (μm)	280	280	280	280	300	300/250
Density (g/cm <sup>3</sup> )	2.32	2.32	2.32	5.32	5.32	5.32
Weight (g)	.26	.26	.26	.59	.64	.64/.53
Pm (mW)	62	71	76	95.2	89.2	91.4
*) η (%)	11.5	13.1	14.1	17.5	16.5	16.9
dPm/dt (mW/°C)	-.320	-.320	-.320	-.192	-.192	-.192
Pm/Pino	.68	.68	.68	.78	.78	.80

\*) Conversion efficiency

Table 1—Comparison of the Characteristics and Electrical Performance of Silicon and GaAs Photocells

Table 2—Type-Approval Program for GaAs Cells Proposed by CISE-FIAR

Type-Approval: Proposed by CISE-FIAR						
Group A	Group B	Group C	Group D	Group E	Group F	Group G
Weldability	Weldability	Uniformity	Humidity	Electron irradiation	A.R. layer gain	Humidity
Rip test	Thermal stress	Humidity	Thermal stress	Temperature coefficient	Cover gain	Thermal stress
	Rip test	Thermal stress	A.R. layer gain	Quantum efficiency	Temperature coefficient	Thermo-vacuum
		Adherence test	Adherence test		Quantum efficiency	Photon irradiation
					Solar absorption	
					Hemispheric emission	

Photon irradiation

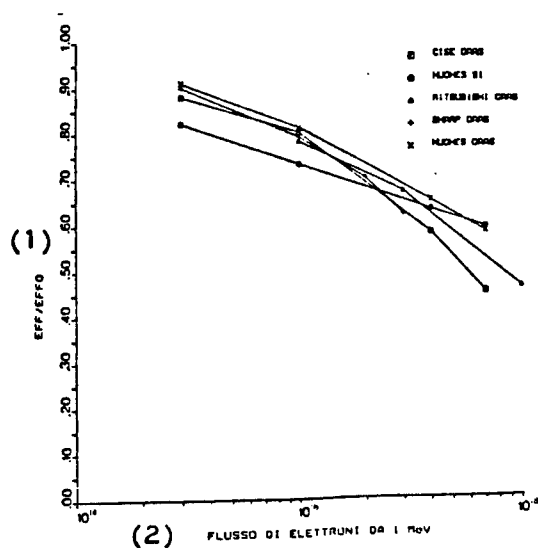


Figure 9

Key:  
1. Efficiency  
2. Flux of 1-MeV electrons

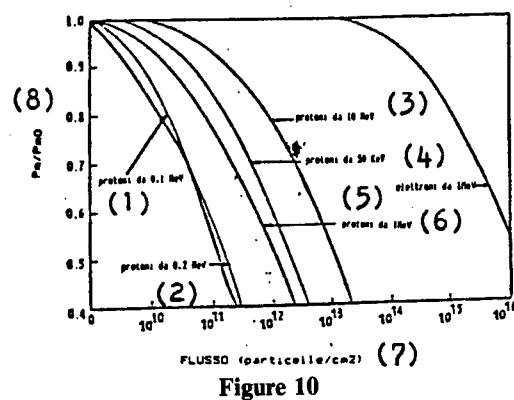


Figure 10

Key:  
1. 0.1 MeV protons  
2. 0.2 MeV protons  
3. 10 MeV protons  
4. 50 KeV protons  
5. 1 MeV protons  
6. 1 MeV electrons  
7. Flux (particles/cm<sup>2</sup>)  
8. Pm/Pm0

Name	Launch date	Weight (kg)	Orbit/year	System capacity (kW)	Installed capacity (kW)
Marecs A	Dec 82	1060	GEO	.75	.9
Meteosat 2	Jun 81	700	GEO/3	.20	.8
Arabsat 1	Feb 85	1195	GEO/7	1.3	1.5
Telestar 3A	Jul 83	650	GEO/10	.9	1.0
Landsat 5	Mar 85	1940	LEO/3	.8	.9
Mos 1	Jul 86	750	LEO/2	.4	.5
Arabsat 2	May 85	1195	GEO/7	1.3	1.5
Dfs 1	Oct 87	1400	GEO/10	1.5	1.7
Olympus 1	Jul 87	2300	GEO/5	3.5	3.9
Space Telescope	Aug 88	11600	LEO/15	5.0	5.5
Sax	92	—	LEO/2	1.3	1.45
Italsat	92	—	GEO/7	1.7	1.9
Eureca	91	—	LEO/0.5	—	5.0

Table 3—Principal Missions in the Period 1980-90

Table 4—Environmental Effects on Solar Generators in Low and Geosynchronous Orbits  
Low Orbit

Environment	Effects on Solar Generator
Heat cycles induced by alternation of sun and eclipses, (6,000 per year; -100/+100 degrees C)	Induced fatigue on interconnections of solar cells
Plasma	Formation of electrical discharges and subsequent decrease of power output
	Erosion of surfaces
	Aerodynamic resistance

Geosynchronous Orbit

Environment	Effects on Solar Generator
Plasma	Formation of electrical discharges and subsequent decrease of power output
Radiation	Damage on solar cells
Heat cycles (100 per year; -180/+70 degrees C)	Mechanical stress

(1) {  
A - CIRCUITO STANDARD  
B - TERMORESISTENZA  
C - FILI AWG  
D - CONTATTI

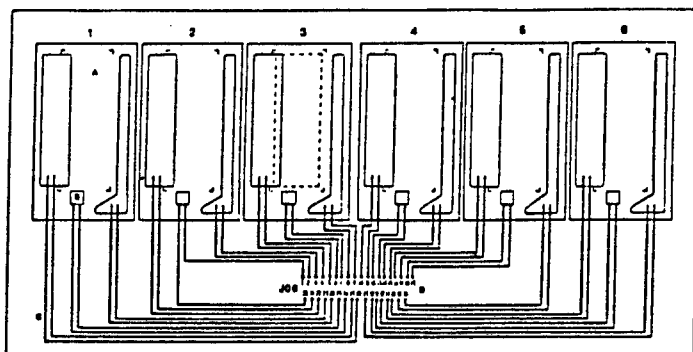


Figure 12

Key:

1.
  - A. Printed circuit
  - B. Thermoresistance
  - C. AWG [American Wire Gage] wires
  - D. Contacts

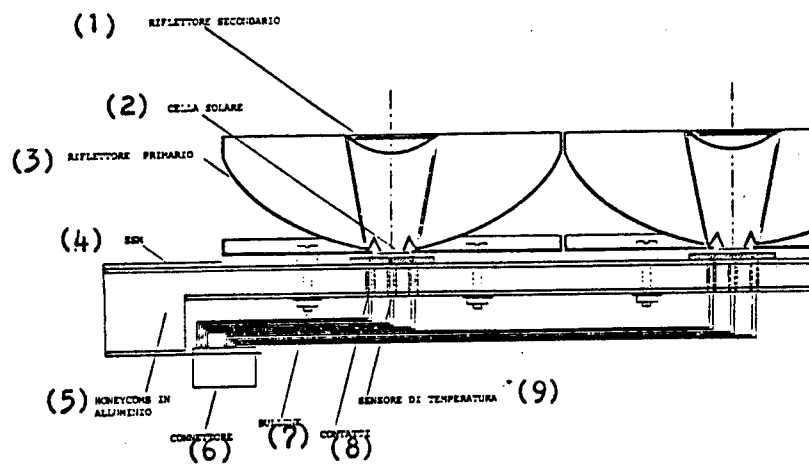


Figure 13

Key:

1. Secondary reflector
2. Solar cell
3. Primary reflector
4. SSM
5. Aluminum honeycomb
6. Connector
7. Bolt
8. Contacts
9. Temperature sensor

Cella (1)	Conc. (sol) (2)	Isc (mA) (3)	Voc (mV) (4)	FF. (%) (5)	$\eta$ (%) (6)
GaAs 1	1	116.4	991	0.79	16.82
Si 1	1	28.3	555	0.75	2.18
Stk. 1	1	—	—	—	19.00
GaAs 2	1	116.9	993	0.77	16.50
Si 2	1	36.0	571	0.75	2.85
Stk. 2	1	—	—	—	19.35
GaAs 3	1	116.2	990	0.78	16.57
Si 3	1	35.5	540	0.75	2.66
Stk. 3	1	—	—	—	19.23

Table 5—Electrical Characteristics of CISE/FIAR  
Stacked Cells

Key:

1. Cell
2. Concentration (suns)
3. ISC
4. VOC
5. FF.
6. [conversion efficiency] (percent)

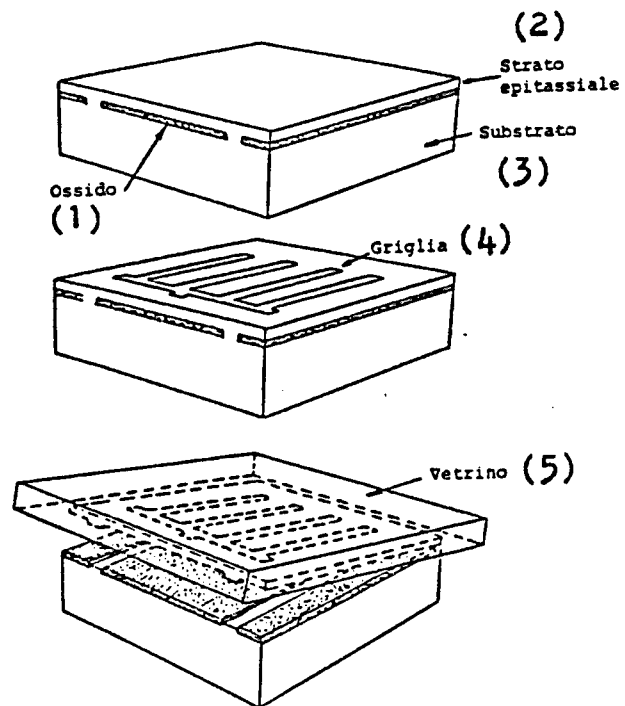


Figure 15

Key:

- 1. Oxide
- 2. Epitaxial layer
- 3. Substrate
- 4. Grid
- 5. Glass cover

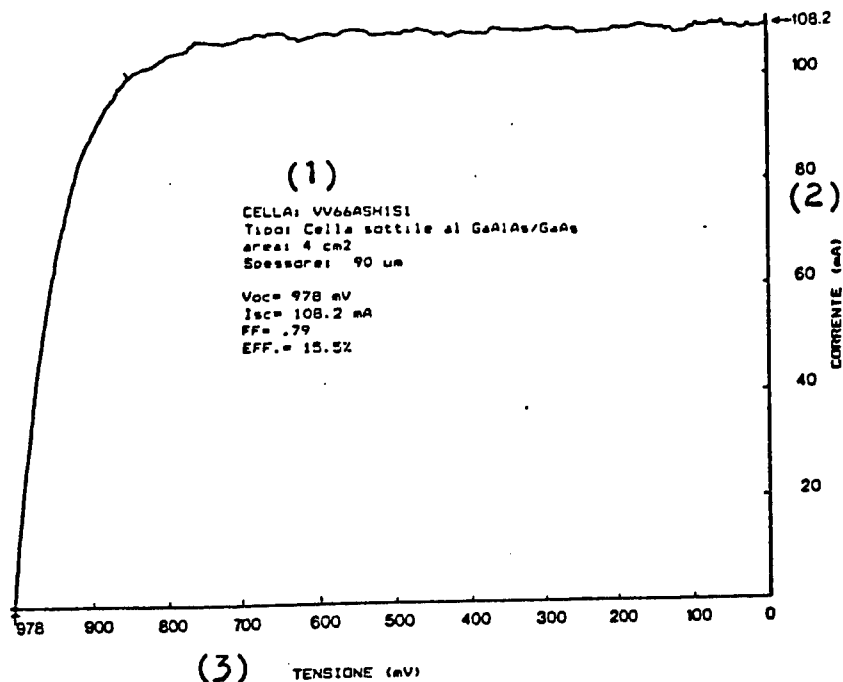


Figure 16

Key

1. Cell: VV66ASH151  
Type: GaAlAs/GaAs thin cell  
Area: 4 sq.cm.  
Thickness: 90 micrometers  
VOC [Open Circuit Voltage]: 978 mV  
ISC [Short Circuit Current]: 108.2 mA  
FF. [Filling Factor]: .79  
Efficiency: 15.5 percent
2. Current (mA)
3. Voltage (mV)

8615

**Italy's Ginatta Titanium-Producing Process Described**

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[Article by Ing. Gianmichele Orsello, of Elettrochimica Marco Ginetta: "Electrolytic Titanium Production Plant"]

[Excerpt] Without discarding any of the experience accumulated over the years, we applied the well-known Italian trinomial SSL—blood, sweat, and tears—to our work on the process and the plant.

The problems encountered and resolved are inherent in the raw material—titanium dioxide, which is transformed into  $\text{TiCl}_4$  by the big international chemical

companies, over 90 percent of whose production goes to the white pigment industry—a raw material that balks at decomposing and releasing the metal. This release of metal requires:

—a quantity of energy not unlike that required to produce aluminum;

—a productive process that takes place at temperatures on the order of 900SDC, under the protection of an inert atmosphere or a vacuum;

—an electrolytic plant that differs from traditional electrolytic plants;

—and rigorous—i.e. modern—operating procedures.

During the many years following the considerations I have mentioned heretofore, we did a considerable amount of innovative applied research relating to the process and the plant, which has enabled us to be in production today with an industrial cell. This cell will



later be duplicated in large numbers that will comprise the large-scale commercial plant. Let's have a look at some photos of the plant (the Modex) [photos not reproduced].

The Modex has the aspect of a large steel container, made structurally robust to withstand the stresses owing to the vacuum, and the function of which is to contain the atmosphere over the bath of molten salts.

The electrodes are supplied with direct current and are displaced by a manipulator. This displacement is essential for continuous production.

A glance at the other side of this plant shows it to comprise a number of subsystems that provide the control room with a precise process-parameters monitoring capability.

The plant is supplied solely with electrical energy and titanium tetrachloride. The function of the rectifiers is to supply the required high-voltage electric current. The  $TiCl_4$  shown, together with the reserve of inert gas, will provide 15 days of production at the rate of 200 kg of titanium a day deposited on cathodes such as those shown.

A detail of the titanium dendrites produced can also be seen.

From the size of the installation and of the cathodes an idea can be had of the financial outlay our company has had to make, considering furthermore that this is the third plant we have built since 1981, following several years of R&D on a laboratory and prototype scale.

9238

#### **CIM Research Expands in Scotland**

*3609m206 Duesseldorf VDI NACHRICHTEN in German No 1, 8 Jan 88 p 10*

[Text] Edinburgh, 8 January 1988 (VDI-N)—Scotland, where more computers are produced per capita than in any other country in the world, also plays a leading role in using computers for production. Several significant initiatives have been taken in recent years to further develop the country's potential in the field of computer integrated manufacturing (CIM). Three separate research and development centers for CIM have been established. In addition to long-term R&D work at the UK national engineering laboratory near Glasgow, several other projects are underway in Scottish universities and polytechnics.

The largest investment in new technologies has been made at Glasgow's Strathclyde University, where an Institute for Computer Integrated Manufacturing has been established. The institute's budget, provided by

Honeywell, Apollo Computers, and the Scottish Development Agency (SDA)—the organization responsible for revitalizing the Scottish economy—totals ECU 3.5 million (1 ECU equals approximately DM2.06).

The second initiative comes from Napier College in Edinburgh which designs CIM systems for individual firms. The college also provides advice on equipment and the related advantages before large-scale investments are made.

Heriot Watt University, also in Edinburgh, has established a new laboratory for "intelligent automation," to work on linking expert systems (artificial intelligence) with existing computer systems and systems development techniques in industrial automation projects.

ECU 1.5 million has been placed at the laboratory's disposal for contract research. The largest individual project is an ECU 880,000 development contract for a multipurpose robot with multipurpose sensors to manufacture small and medium-sized products.

Several CIM-related projects, including vision robots, automatically guided vehicles, and flexible production are underway at the UK national engineering laboratory in East Kilbride.

08702

#### **AEROSPACE, CIVIL AVIATION**

##### **Future Post Ariane 5/Hermes Space Launchers**

*3698M214 Friedrichshafen DORNIER POST in English No 3, 1987, pp 50-52*

[Text] Long Lead European Goals

During the minister-conference in Rome 1985 a long-term goal for the European Space Programs has been set which means (after spacelab) a certain degree of autonomy also in the manned space activities.

This is already reflected in the decisions for the current programs Columbus, Ariane 5 and Hermes. As a further growth of the man-tended freeflying laboratory (MTFF) a permanently manned European Space Station can be envisaged being composed of several MTFF-modules (one of the modules acting as habitat). Such a station, of course, will require regular servicing-missions for supplies and crew exchange in longer periods of time (several months).

In addition also unmanned return missions of produced samples, can be envisaged, outside the regular servicing mission schedule, using ballistic re-entry capsules, which could also be used as rescue capsules for the crew, if required. For such long-term goals improvements of the space transportation systems under development for the initial "consolidation-phase" will be required, especially in the area of reusability for the launchers used for

transport in low earth orbit, as well as for orbital operations (robotics and extra vehicular activities (EVA), in order to cope with the increasing mission frequency (cost), expected later.

Hermes—due to schedule and mass-constraints—can only be considered as a “technology-demonstrator” for the later application phase, to be used already for the limited initial MTFF-operations.

Besides this new type of space application for Europe, of course the well proven unmanned commercial space applications in geostationary orbits (telecommunication) as well as satellites for earth observation/meteorology and scientific experiments shall be mentioned, which will require a versatile and economical transportation system.

For the definition of the future European Space Launcher the BMFT therefore decided on the following requirements:

- PL-capability, manned—return mission about 4t
- PL-capability, unmanned—one way: about 15t (This figure shall also include geostationary and other high-energy missions with corresponding upper stages)
- Mission-frequency, manned: 5 per year
- Mission-frequency, unmanned: 7 per year
- A significant recurrent cost reduction shall be reached (with still reasonable development cost)
- Time frame for the development: 1995 to 2005/2010

#### Alternative Concepts

Triggered by the proposals of British Aerospace (UK) concerning a horizontal launched single stager space launcher, using “air breathing” engines (Hotol), MBB proposed a horizontal launched two-stager concept, called Sanger II, also using air-breathing engines for the first stage. (MBB/ERNO in Bremen proposed a similar concept to Hotol, called Lart.) Dornier and MAN mainly looked into the vertical take-off launchers, while Dornier in addition also investigated the horizontal, airbreathing launcher option with respect to the technologies and time frame required. In the following the vertically launched “EARL- Family” (European Advanced Rocket Launcher), proposed by Dornier shall be discussed.

The first stage consists of a 5,5m diameter cryogenic fly-back vehicle (similar to the past ESA study FLS with Dornier participation), using approximately 160t of propellant. (For the return flight of the stage, conventional turbojet engines will be used for a safe horizontal landing-approach.) In addition to such a first stage, depending on the individual mission-requirement, the following stages have been proposed:

- A reusable manned second stage, i.e. a follow-on development of Hermes with an own propulsion system and a reasonable servicing-oriented payload

capability (flight support equipment, ORU's, supplies, etc.)

- An expendable cryogenic second stage (H70) which is designed mainly for the geostationary missions (transfer orbit), but also to be used for the low earth orbit cargo missions (18t payload), such as MTFF modules.

Instead of a heavy payload in LEO also a smaller payload plus a respective upper stage (medium-energy or high-energy propellant) can be envisaged for sun-synchronous or planetary scientific missions. Thereby a good mission-versatility (cost effectiveness) can be reached with the concept of the EARL family.

#### Technology Requirements

The life-off weight of the EARL-vehicles will be approximately 270t which means that an engine thrust in the order of 340t will be required (3 x 115t cryogenic rocket engines have been proposed, a follow-on development of the HM 60 engines, which are presently under development for Ariane 5).

For the manned return vehicle (Hermes-FO) the development of the ATC- 700 would be desirable, which has been proposed by MBB.

Also with respect to the technology advances in the structural area, as well as in the field of avionics and aero/thermodynamics, the EARL concept will be sufficiently demanding to justify national preparations in a hypersonic technology program, as presently planned.

The realization of an air-breathing, horizontally launched space transport vehicle, such as SangerII, due to the extensive propulsion technology to be solved as well as the development cost in the light of the still limited mission frequency for the period 2005/2010, should be seen for a later time period. (This does not exclude an immediate start of the long-lead technologies for such an eventual application.

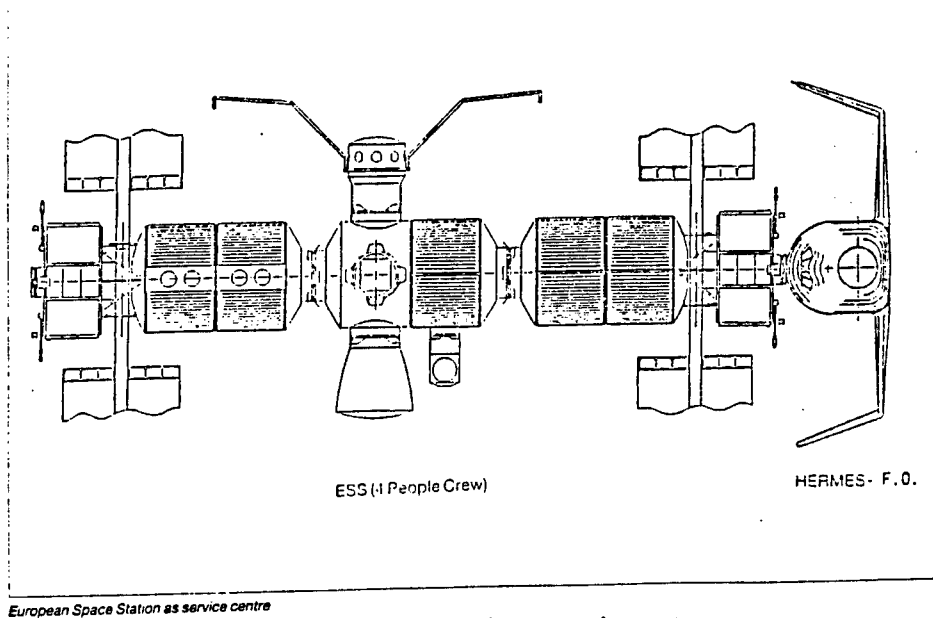
#### Program Planning

Based on estimates, presently available for various launcher alternatives, the development cost of the conventional, vertical launched EARL-concept would be approximately 1/3 as compared to the airbreathing, horizontally launched concept (SangerII). The reduction in operational cost as compared with Ariane 5 will be approximately 50 percent (while 30 percent are expected for the air-breather-concept).

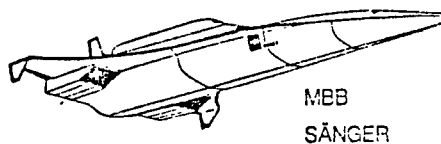
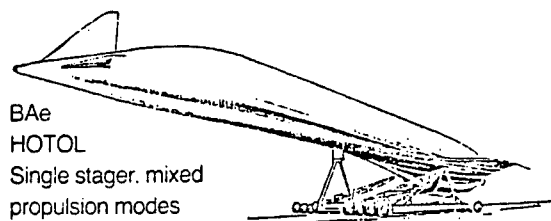
In the light of reliability (manned space flight) as well as due to time and cost constraints of the European Space Program, Dornier recommends a “phased development-approach,” avoiding two large technology steps for the follow-on project after Ariane 5/Hermes.

First of all, however, Ariane 5 and Hermes must be realized, the technology of which is either available or already in preparation. The national "Hyperschall-Technologie-Programme" in the fields of propulsion, structures, materials, avionics, data management, energy- and life support systems, as well as the relevant simulation- and test-facilities should be long

range- oriented (Sanger). However, after a decision has been reached with respect to the "Post Ariane 5/Hermes" vehicle (ESA-FESTIP Programme)—emphasis should be placed on the needs of such a development, which still could be a vertically launched vehicle such as EARL, due to the existing constraints in the European Space Program.



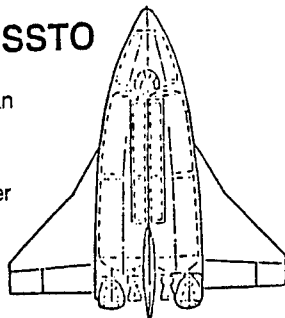
European Space Station as service center



two stager, Turbo ramjet/rocket

### SSTO

North American  
Rockwell  
Single stager  
rocket launcher

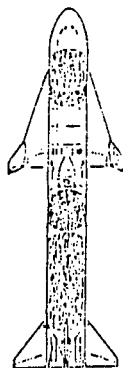


### TSTO

EARL

**DORNIER**  
Dornier System GmbH

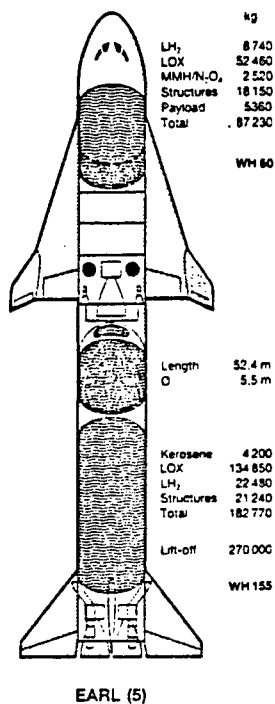
Two stager  
rocket launcher



Advanced reusable launch vehicles (Europe)

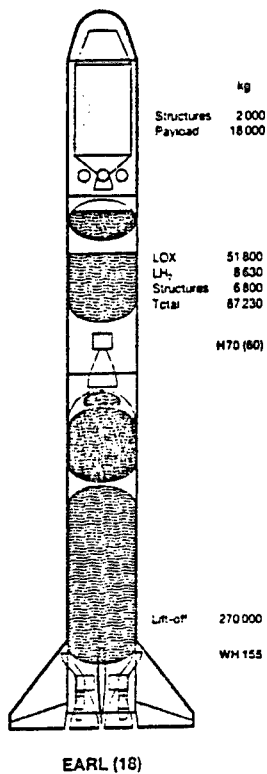
Advanced reusable launch vehicles (Europe)

Manned Return  
mission



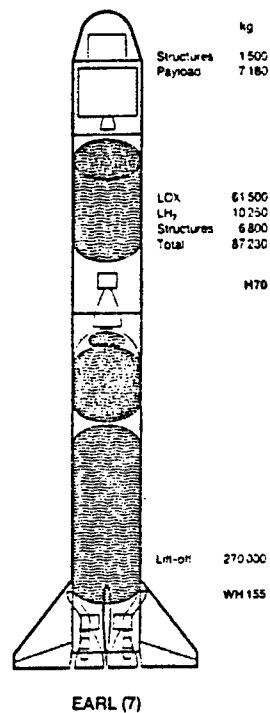
*The EARL family*

Unmanned Cargo  
Transport in low earth orbits



*The EARL family*

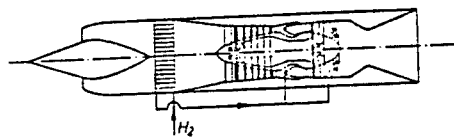
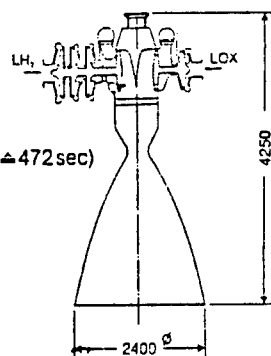
Unmanned geostationary  
missions



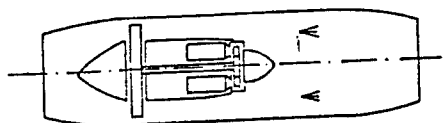
## Advanced Future Topping Cycle Engine

MBB-ATC 700

● Propellants	LOX/LH <sub>2</sub>
● Mixture Ratio (O/F)	6.0:1
● Specific Impulse (vacuum)	4630 Nsec/kg ( $\approx 472$ sec)
● Thrust (vacuum)	700 kN
● Mass Flow	151.8 kg/sec
● Exit/Throat Area Ratio	300:1
● Chamber Pressure	240 bar
● Engine mass	900 kg
● Throttle range	50 - 100 %



Advanced Turbojet  
with Pre-cooling



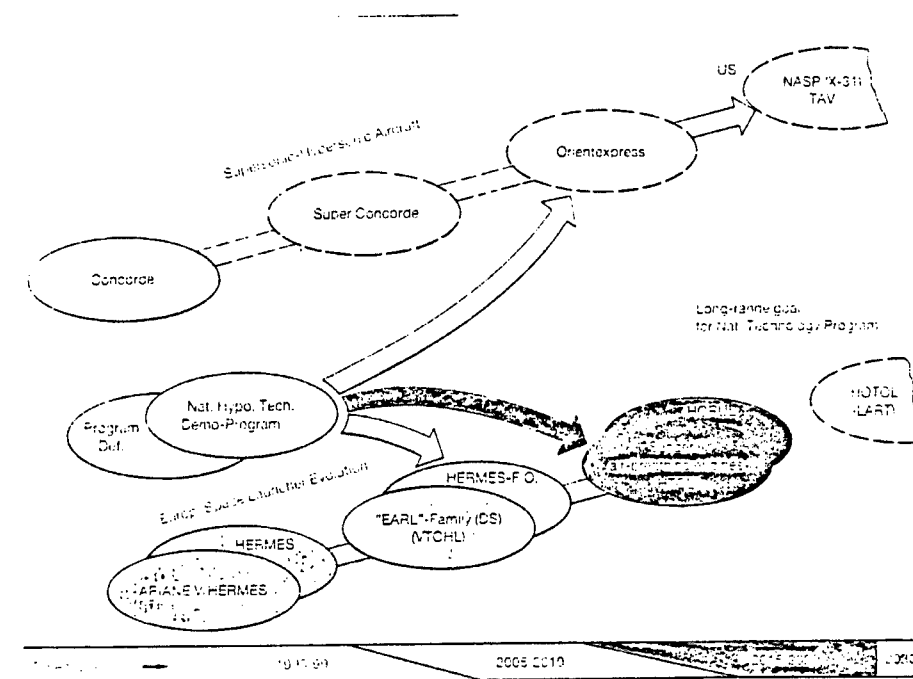
Turbo-Ramjet  
(integrated) with  
Gas Generator  
(Alternative: Heat Exchg.  
+ GH<sub>2</sub> Turbine)



Turbojet / Ramjet  
(alternative operation)

*Future propulsion technology (space transportation systems)*

**Future propulsion technology (space transportation systems)**



Evolution of European space launchers

Evolution of European space launchers

8800

### Highly Precise Reflectors, Mirrors in Fiber-Composite Technology

3698M215 Friedrichshafen DORNIER POST in English  
No 3, 1987 pp 53-54

[Text] Ultraprecise reflectors and mirrors using fiber-composite technology are produced by the replica process. To do this, a female mould is needed whose contour accuracy essentially determines the feasible precision of the component formed with this mould. This process has the big advantage that the precision has to be achieved only once, and then any given number of components of the same quality can be produced.

The use of fiber-composite technology for reflectors and mirrors offers the following advantages:

- high mechanical strength and stiffness
- low weight
- thermal stability
- long service life
- simpler and fast production.

More than 10 years ago, Dornier developed the first reflector of carbon-fiber reinforced plastic (CFRP) for a 2-meter offset satellite antenna under the Federal Research and Technology Ministry's (BMFT) program

for "Future Communications Satellites" (Zukunfftige Kommunikationssatelliten—ZKS). The light, yet very stiff reflector consisted of a sandwich structure with ultrathin CFRP layers and an aluminium honeycomb core and was produced on a machined gray cast iron mould. The contour accuracy of 100 µm was surprisingly good. As CFRP is electrically conductible, no coating is necessary for wavelengths above 15 mm (below 20 GHz). For shorter wavelengths or higher frequencies, all fiber-composite mirrors must have a metal coating. When developing the antennas for Kopernikus, the German communications satellite (DFS), Dornier qualified the vacuum depositing of aluminium on CFRP for space applications.

Highly mobile ground stations with segmented reflectors 3.3 to 4.5 meters in diameter were also developed by Dornier for satellite communication.

By a combination and improvement of these very different developments, increasingly ambitious projects could be performed. For the 30-meter radio telescope on Pico Veleta in Spain, for example, the 2-meter subreflector was developed and delivered as well as 420 aluminium sandwich panels. The reflector must be very light and yet very stiff, as it is wobbled very fast.

The metal-coated CFRP sandwich has a production accuracy of 15 µm rms.

The design of the mirror for the 3-meter telescope of Cologne University is similar to that of the mobile 3.3-meter ground antennas. The four segments cannot be separated but can be adjusted within certain limits, and they have been produced with more precise moulds leading to a contour accuracy of 25  $\mu\text{m}$  rms.

For the sub-millimeter wavelength range and for the far infrared range, accuracy must be better by a factor of 10. In several feasibility studies for different projects, it was proven that fiber-composite technology could be an attractive alternative for these wavelengths as well.

For two corresponding projects, the "3-meter Far-Infrared and Submm Balloon Telescope" for the University of Arizona in the United States and the "Large Deployable Reflector" (about 20 meters in diameter) for NASA's Jet Propulsion Laboratory, Dornier built several panels of identical geometry with nearly identical requirements as to manufacturing accuracy better than 2  $\mu\text{m}$ , mass below 10  $\text{kg}/\text{m}^2$  and operating temperature range. They were all tested at the Steward Observatory of the University of Arizona, especially with regard to their temperature behavior down to about -60 degrees Celsius.

Within this development series, analytical methods were significantly improved, enabling a precise prediction of the panel behavior under such loads as

- manufacture
- temperature changes
- humidity
- gravity.

Thus it was possible to optimally balance the design parameters, fiber material and orientation of the fiber layers, as well as type, material and orientation of the core structure.

A ground glass mould (precision 1.5  $\mu\text{m}$  rms) was used to produce panels, the precision of which was improved in steps up to 1.8  $\mu\text{m}$  rms. At the same time, thermostability was improved so far that deformation was only 0.6  $\mu\text{m}$  rms for a temperature difference that was approximate equal to -80 degrees Celsius.

The mass of the panels is 6  $\text{kg}/\text{m}^2$ , which is extremely low. Thus it could be demonstrated that fiber-composite technology can be used for the sub-millimeter and the far-infrared ranges.

A feasibility study undertaken for ESA investigated whether this technology can be transferred to ESA's ambitious FIRST (Far Infrared and Submm Space Telescope) project. For a diameter of 8 meters, a contour accuracy including all errors of less than 10  $\mu\text{m}$  rms is to be reached. A test panel of nearly the original size has been built and tested.

For the SOFIA (Stratospheric Observatory for Infrared Astronomy) project planned together by BMFT and NASA, a light-weight mirror about 3 meters in diameter is required for installation in a Boeing 747. Due to the even higher precision requirements (infrared to visible light), the replica process employed until now is no longer sufficient. First trials in cooperation with the University of Arizona have shown that it is possible to apply coatings on CFRP which can be ground and polished with less polishing pressure and faster than glass to obtain the required precision.

A novel support system linked with the design for homologous deformation, that is, the deformation generated under load forms a new paraboloid and thus only an uncritical focal length change, entails weight advantages if compared to a light-weight glass mirror with an 80 percent weight reduction (compared to a solid glass mirror).

The mirrors of the Wolter-1 telescope for the ESA XMM (X-Ray Multi-Mirror Satellite) are intended for even shorter wavelengths. For this purpose, double-cone cylinders 600 mm long and up to 700 mm in diameter having a reflecting surface are needed. The global deviations from the ideal contour must not exceed 5  $\mu\text{m}$ , and the surface quality must be better than 10 Angstrom ( $=0.001 \mu\text{m}$ ). For a planned wall thickness of only about one millimeter, the first requirement cannot be fulfilled with a glass mirror, but it can with a CERP.

In order to meet the extreme requirements for surface quality, the already very smooth CFRP surface must be coated with different materials in a second replica process on a superpolished form. The optimum coating sequence was calculated by Dornier by means of a micro-mechanical model. On samples produced in cooperation with Zeiss using this process, surface qualities better than 5 Angstrom could be reached.

These last few examples impressively demonstrate the possibilities of fiber-composite technology in the optical field, and a considerable application potential still remains uncovered.

8800

#### **Dornier's High-Power Amplifier in Microwave Frequency Range Outlined**

*3698m216 Friedrichshafen DORNIER POST in English No 3, 1987, pp 55-57*

[Text] Dornier's development work started with preliminary studies and test set-ups of communications amplifiers for space application. The next step was radar amplifiers for the Spacelab-borne MRSE (Microwave Remote Sensing Experiment), radar amplifiers for ERS-1 and ERS-2 (European Remote Sensing Satellite), and for X-SAR (X-Band Synthetic Aperture Radar) for the U.S. Space Shuttle. Another amplifier system was introduced into the Canadian Radarsat Program—



against American competition. Besides these space developments, the program is now being extended for applications in aircraft, ground stations, and military equipment. The know-how gained in space projects can be profitably used here.

The high-power amplifier, consisting of the amplifier tube and a specially adapted, very sophisticated power supply (Electronic Power Conditioner—EPC), is faced with extreme requirements. High pulsed power (up to 5kW) must be generated with an amplitude and phase error of less than 0.2 dB and less than 3 degrees pp, respectively. The EPC must supply a regulated high voltage of up to 20kV with a tolerance of less than 0.1 percent in pulsed operation. For space applications, the amplifiers must operate under normal air pressure for test purposes, as well as in a vacuum environment. The components used must be optimized for high efficiency, low weight and volume, and for high thermal and mechanical load resistance. In addition, space research applications require high reliability and lifetime. This task requires a systematic approach in electrical, mechanical, and thermal design as well as the application and mastering of new technologies.

Extensive verification and qualification tests form a decisive part of each equipment development. In space applications, comprehensive lifetests are especially important, because they are to prove the suitability of the equipment for long-term operation. Complete amplifiers and technologically critical parts are tested up to 2 years under thermo-vacuum conditions.

Developments and technical solutions worked out for space projects can also be transferred to aircraft and ground station applications. The less severe environments—if compared to space conditions—here often allow the use of simplified solutions.

The traveling wave tube (TWT) is predominantly used in space applications. In radar applications, the klystron is an alternative solution, as Dornier has shown by its pre-development of a klystron amplifier. The tubes are specified and developed in close cooperation with the tube manufacturers. A renowned supplier for traveling wave tubes for all applications is AEG-Rohrenwerk, of Ulm/Germany, with which Dornier has cooperated for years.

The essential characteristics of a space tube are shown by the example of an ERS-1 traveling wave tube:

- Utilization of a mixed metal cathode to guarantee a lifetime of several years. The mixed-metal cathode is characterized by high emission and relatively low cathode temperature (1050 degree C)
- Lifetime is verified by lifetests performed with sample cathodes
- A mechanically and thermally stable copper grid for modulating the cathode beam which is suitable for reliable long-term operation

—The delay line is a rugged molybdenum “ring-and-bar structure” permitting, among others, a thermally well balanced design principle

—A three-stage collector provides high efficiency.

### Power Supply

The sophisticated power supply (Electronic Power Conditioner—EPC) does not only generate the high voltages required for operating the tube but also assumes important control and protection functions. As such special power conditioners for space applications were not available on the world market, Dornier had to start its own development. The company thus had the chance to penetrate into a promising field of activity and to gain valuable know-how.

The Electronic Power Conditioner is composed of the low-voltage electronics (control stages/inverter) and the high-voltage assembly (high-voltage transformers, rectifiers, filter capacitors, and the grid modulator).

The low-voltage electronics, especially the inverters, are part of the proven Dornier technology but the available circuit technologies must be adapted to the special requirements of each application. This technology has been successfully used in nearly all German and European space projects.

The technology for the high-voltage assembly—especially insulation technology—which is described in detail in this article, is a difficult and demanding field. A minute error in the design and production of high-voltage components can lead to a catastrophic failure of a device, causing immense economic damage, above all in space applications.

### High-Voltage Technology

Even with standard equipment, it is difficult to master high tensions in power supplies. In space applications, complicating factors and special operating conditions, such as

- Operation under ambient pressure (during tests)
- Operation under vacuum conditions (space/simulation)
- High mechanical stress generated by vibrations during the rocket launch
- A high number of thermal cycles due to the change between sun and shadow phases during the terrestrial orbit of the satellite and due to changing operating conditions of the amplifier
- Small and light construction
- High operational reliability and endurance increase the overall difficulties.

The Dornier-developed insulation technology fulfils all the requirements resulting from the above-listed operating conditions. All high-voltage components—transformers, rectifiers, and capacitors—developed and processed insulating material. For the safe application of this technology, the following criteria are decisive:

- Precise design for high-voltage technology, that is suitable shape and arrangement of parts in order to avoid high electric field strengths
- Selection, specification, and continuous control of the material used
- Precise monitoring and control of the processing methods
- Efficient mechanical and electrical production tests considering special criteria
- Lifetests in extreme environments.

The following means and methods are used for the theoretical design of high-voltage equipment: special computer programs for determining the electrical field strength, and analytical methods to determine mechanical, thermodynamical, and electric loads on the basis of the finite element method.

All critical points in high-voltage assemblies are analyzed and optimized with these methods.

For experimental investigations and production quality tests, Dornier has invested much capital into a high-voltage development and test laboratory, a materials analysis laboratory, and a vacuum encapsulation facility following equipments are available, among others.

- Partial-discharge measuring instruments for non-destructive component testing, consisting of a.c. and d.c. high-voltage generators up to 140 kV and a partial-discharge measuring instrument with a sensitivity of 0.1 picocoulomb
- High-voltage insulation test equipments
- Installations for non-destructive analysis of the chemical composition of materials
- Thermo-vacuum chambers for accelerated aging under severe environmental conditions
- X-ray equipment for the investigation of severely stressed materials and components
- Scanning electron microscopes for the presentation of surface structures.

High-voltage assemblies are produced by means of a special encapsulation facility, which allows a defined preparation facility, which allows a defined preparation

of the encapsulation compounds (mixing, temperature control, degassing) and encapsulation under specified pressure and temperature conditions. All materials delivered to Dornier are submitted to a specified incoming inspection. Extensive installations are available for non-destructive testing of encapsulated components. In addition, samples are taken from each lot for special analyses, such as microsections for further investigations.

The precise chemical and mechanical analysis for the selection and quality control of encapsulation compounds suitable for space applications, is mainly performed with the following procedures:

- infra-red spectroscopy
- dynamic-mechanical analysis
- thermo-mechanical analysis
- differential calorimetry
- high-pressure liquid chromatography.

Electric production testing comprises very sophisticated measurements to verify the required characteristics. One of the most important control steps is the check for internal partial discharges. If partial discharges occur in an insulating material, this indicates the presence of cracks or shrinkholes which can lead to accelerated aging and destruction of the high-voltage assembly. The non-destructive partial discharge test excludes faulty products.

#### Lifetesting

Before products are delivered to the client, production and qualification tests of the individual components and the complete amplifier are mandatory. One of these tests is the extensive lifetest. Dornier has installed special test chambers for simulating extreme environments. The tube manufacturer has similar installations.

With this long-term experience in the development of microwave amplifiers and in high-voltage technology as well as in the controlled production of high-voltage assemblies, Dornier can fulfil extreme requirements of satellite and aircraft-borne, as well as terrestrial, applications.

Especially in the field of high-power amplifiers for space applications, Dornier has proven with its range of products that it is a reliable and renowned partner.

The most important developments of high-voltage amplifiers in the microwave frequency range

	Frequency	Peak power	Mean power	High voltage	Operating mode	Tube	Application
ESA R&D	12.6 GHz	150 W	150 W	6 kV	CW	TWT	Study
TV-SAT	12.6 GHz	260 W	260 W	7 kV	CW	TWT	Study and electrical model
MRSE	9.6 GHz	3 kW	340 W	10 kV	pulsed	TWT	Space

The most important developments of high-voltage amplifiers in the microwave frequency range

	Frequency	Peak power	Mean power	High voltage	Operating mode	Tube	Application
HPA							Space Shuttle, Spacelab generation of radar images in SAR mode, SCATT mode operation
RSPP TWT Amplifier	5.3 GHz	5 kW	320 W	15 kV	pulsed	TWT	Preliminary study for ERS-1 with electrical mode
RSPP Klystron Amplifier	5.3 GHz	5 kW	320 W	15 kV	pulsed	Klystron	Preliminary study for ERS-1 with electrical mode
ERS-1/ERS-2 HPA	5.3 GHz	5 kW	300 W	14 kV	pulsed	TWT	Space Ariane Generation of radar images in SAR mode, SCATT mode operation
X-SAR HPA	9.6 GHz	3 kW	240 W	15 kV	pulsed	TWT	Space Shuttle generation of radar images in SAR mode
RADAR-SAT HPA	5.3 GHz	5 kW	320 W	14 kV	pulsed	TWT	Space Generation of radar images in SAR mode
Intelsat HAP (study)	11 GHz	10 W	10 W	3 kV	CW	TWT	Space study Communications transponder
DO-SAR C-Band	5.3 GHz	1 kW	40 W	5.5 kV	pulsed	TWT	Aircraft-borne Experimental radar system generation of radar images in SAR mode
DO-SAR Ka-Band	35 GHz	1 kW	40 W	20 kV	pulsed	TWT	Aircraft-borne Experimental radar system generation of radar images in SAR mode
30 GHz HPA	30 GHz	200 W	200 W	17 kV	cent. operation	TWT	Ground station for satellite communication (proposal stage)

Lifetests, shown by the example of the ERS-1 microwave amplifier

Sample	Number	Time in months	Environmental and test conditions
High-voltage transformer	7	12	Vacuum and thermal/electric cycles
High-voltage capacitor	6	12	
Traveling wave tube (cathode)	10	24	Atmospheric pressure and thermal/electric cycles
Microwave amplifier	1	24	Vacuum and thermal/electric cycles
Microwave amplifier	1	12	Atmospheric pressure and thermal/electric cycles

08800

**MBB Starts HERMES Development Program**  
*3698m208 Duesseldorf VDI NACHRICHTEN in  
German No 2, 15 Jan 88 p 14*

[Unattributed article: "Europe's Space Shuttle in Pre-development Phase; Hermes Flies in Wind Tunnel; Aerodynamicists Determine Best Form for Safe Shuttle Flight"; first paragraph is VDI-NACHRICHTEN introduction]

[Text] Bremen, 15 January 1988 (VDI-N)—Since 1 January, Phase I of the Hermes development program has been underway within the framework of the ESA [European Space Agency]. In November 1987, the ESA member states decided at the ministerial level to allow the preliminary development work to be carried out over a 3-year period. The decision whether to construct the Hermes space shuttle will follow an examination of Phase 1 results. The wind tunnel tests are well underway at MBB [Messerschmitt-Boelkow-Blohm] with measurements to determine the space shuttle's optimal configuration for atmospheric flight.

The first current flow measurements on a model of the European space shuttle Hermes have begun in the wind tunnel of the MBB cargo and transport aircraft group. As part of the preliminary development of the Hermes project, MBB has the contract to undertake numerous measurements on different sized models. These measurements will be used to determine the space shuttle's optimal configuration for atmospheric flight. The tests are carried out in several of the European aerospace industry's wind tunnels and at research institutions.

The model tested at MBB's wind tunnel in Bremen is a breakthrough in terms of manufacturing engineering. For the first time, a computer system has been used that directly converts the three-dimensional form of the space shuttle from the computer screen into control functions that guide a milling machine at MBB's milling center in Varel near Wilhelmshaven. With this system, called CATIA [Computer Graphics Aided Three Dimensional Interactive Application], the overall working procedures are accelerated, production accuracy is increased, and there is a considerable decrease in possible sources of error.

This first Hermes model to be tested at MBB is on a 1:15 scale and is made of aluminum. While the model's hollow fuselage was cast and then milled to its shape, the wings, flaps, and tailpiece were made from a solid aluminum plate. The individual pieces were screwed together. The required tolerances, compared to an overall model length of about 1 meter, are 1 mm long and 0.1 mm thick. At the Varel works, these figures have been considerably reduced, thus representing a success for CATIA manufacturing system. This provides the necessary basis for using wind tunnel measurements to achieve safe, reliable forecasts for space shuttle flight requirements in a large scale prototype.

The roughly 80 kg space shuttle model is suspended by six thin steel wires in the wind tunnel so that it hangs almost freely in air. This means that the currents can flow freely around the surface of the model. The wires have only an insignificant influence on the current flow in the working section. Furthermore, such an influence on the current flow can be estimated with great accuracy. The forces released by the current in the wind tunnel that work on a model such as this are measured and used to determine the optimal form.

The structure of the German aerospace group's Hermes model is purely a research project. In certain areas its geometry has been altered in comparison with the original Hermes geometry. This was necessary to investigate the influence of form changes on the space shuttle. In the final analysis, it is one of the tasks of aerodynamics to achieve the optimal form for this space vehicle by means of a series of changes in its geometry. For this reason the first completed measurements in Bremen will not remain the only ones. Further measurements on around ten different models are planned for the cargo and transport aircraft field.

Hermes, which is expected to land safely at an airport after completing its tasks in orbit, will be launched by an Ariane 5 rocket from Kourou in French Guyana, South America. After the orbital mission, the landing will not take place in French Guyana.

As opposed to the American shuttle, Europe's Hermes has no propulsion equipment of its own. This means that the spacecraft must land on Earth like a glider. After reentering the atmosphere at a speed of Mach 25, or 7.8 km/sec, Hermes must be able to control the entire range of speeds of an aircraft until landing.

The stresses and loads differ considerably at the various stages of speed. Heavy temperature loads are to be borne at high speeds, and the spacecraft's sturdy construction, with its blunt nose, is a result of this. In the subsonic stage, it is necessary to have both gliding ability and effective steering, as Hermes must land like a glider without the help of an engine—albeit at a considerably higher speed, around 300 km/h.

In fact, different forms are necessary for optimal flight in each of the different stages of speed, such as hyper-, super-, and subsonic. For example, the forward section of the fuselage is constructed according to the requirements of hypersonic flight, while the wing size and the lateral tailplane and control surface dimensions are dictated by the speed during the landing approach. The landing requires a high degree of research and development, in which the German firm is particularly involved.

This research is primarily necessary to ensure safe flight termination phases even under unfavorable weather conditions such as side winds. The measurements will be used to optimize the final form of the space shuttle, its steering surfaces, and its landing gear.

08702

**BMFT, MBB-ERNO, KRUPP ATLAS Subsidize Microgravity Facility**

*3698m209 Duesseldorf VDI NACHRICHTEN in German No 2, 15 Jan 88 p 15*

[Article by Margarete Pauls: "Free-fall in microgravity; Europe's First Free-fall Tower Has Been Constructed; Expensive Space Flights No Longer Necessary;" first paragraph is VDI-N introduction]

[Text] Bremen, 15 Jan 88 (VDI-N)—In 1989, Bremen university will have an additional landmark. By then, the world's most modern gravity tower, with a height of 144 meters will rise above the university compound and be visible from afar. The gravity tower creates the conditions necessary for scientific research under microgravity conditions on the ground. It is very cost-effective and complements existing experimental space flight facilities.

Construction of the gravity tower is scheduled to start this year. It will be the main structure of the center for applied aerospace technology and microgravitation (ZARM). The project is financed by the Bremen land, the FRG's minister of research and technology, the education and science ministry, and the Bremen companies MBB/ERNO space technology, Krupp Atlas electronics, and OHB System, which will carry out the DM24 million gravity tower project in cooperation with ZARM.

Worldwide, only two gravity towers exist at present, in the United States. After an operational life of 20 years, however, they no longer reflect the present state of technology. The gravity tower in Bremen consists of a 110 meter high free fall pipe with an internal diameter of 3.5 meters, a brake chamber 11 meters high at the base of the pipe, and a launching pad at ground level. At the center of the system is a specially developed pressure-proof and extremely shockproof drop capsule.

At the Bremen gravity tower a drop of 110 meters will take 4.5 seconds. A launching device will be installed at the base of the tower at a later stage. The capsule will then be "hurled" up in the air, thus doubling the time under microgravity conditions to 9 seconds. Because the state of microgravity can only be reached when there are no forces of lift, the entire pipe must be evacuated prior to each experiment. In order to determine the optimal means of braking the capsule's fall after a drop of 110 meters, preliminary experiments are being conducted at present in the 25 meter service shaft of the main building at the University of Bremen. The ZARM scientists are testing potential brake tanks and capsule forms, and intend to lower the maximum deceleration during braking to under 25 g (25 times the earth's acceleration due to gravity) in order to minimize the stress on the capsule and reduce the number of experiments.

In the fields of pharmacology, biotechnology, processing technology, and the manufacture of new metal alloys, microgravity conditions will lead to findings that cannot be obtained in the earth's gravity field. Besides basic research, microgravity experiments provide insight on terrestrial processes and technologies and their optimization. Potential industrial applications of special microgravity manufacturing techniques must be tested and prepared.

Because of the very short time available for experiments, only certain phenomena can be investigated under microgravity. Very rapid chemical reactions such as combustion processes often lasting only one second, or phenomena related to fluid mechanics and solidification of materials are well suited to these conditions. This type of research is either independent of space experiments or is useful for preparing and optimizing such experiments. In testing liquids under microgravity conditions, scientists are interested, for example, in wetting effects, capillarity, formation of drops, positioning of drops, and interactive processes between drops. Spraying will be part of the experiments as well as filling and emptying processes. In addition, fluid mechanical research on electrophoresis and fermentation in microgravity are planned in the field of biotechnology.

A computer in the drop capsule will supervise and control the experiments. The read-out data is either recorded in a semiconductor memory inside the capsule or is transmitted to a processor installed on the ground. Scientists can also follow their experiments on a monitor. A special video camera as well as a high speed camera with up to 6,000 frames per second record the experiments in the drop capsule. The gravity tower in Bremen will significantly expand the capabilities of microgravitational research in the FRG. Up to three drops per day will be possible. The cost per experiment will range from a few hundred to thousands of DM, which is far less than the millions required, for example to launch a high altitude rocket.

FRG scientists have had several years of experience with microgravity experiments, and their equipment also allows for experiments of longer duration than in the gravity tower.

Besides free-fall, microgravity is also used during ballistic flight and in space. To generate microgravity in a payload capsule, the latter must move in orbit which is also possible without propulsion in the earth's gravity field. Theory shows that this orbit must be parabolic, hyperbolic, elliptical, or circular.

The 10 year-old research program Texus [Technological Experiments Under Microgravity] has already done significant preliminary work for the successful space experiments of the D1 mission. Texus was initiated in 1977 by the BMFT, and has been carried out since then by the German Experimental Institute for Aeronautics and

Astronautics (DFVLR), and numerous individual scientists. Fourteen Texas rocket flights have made 125 microgravity experiments possible. A scientific payload is carried to an altitude of 250 km with a high altitude rocket. During a free-fall of 5 to 6 minutes, it is exposed to almost absolute microgravity. After that, the experimental payload returns to earth by parachute, and can be reused.

The planned TOPAS program (transport operation of micro-g payloads assembled on scout)—a joint project between the FRG and Italy with special emphasis on gravitational research—will allow missions of 1 to 2 days, and up to 3 weeks to take place in an earth orbit with a reusable payload capsule. Short periods of zero gravity lasting up to 60 seconds are possible with the drop capsule program Mikroba (Micro-g with balloon). A balloon carries the Mikroba drop capsule to heights between 40 and 45 km and allows it to fall. Additional thrust compensates for the aerodynamic resistance which increases with the distance to be dropped. These balloon flights can supposedly be accomplished at one fifth the cost of the rocket flights commonly used at present. Three to eight balloon launches per year can be made starting in 1988 within the framework of the Mikroba program.

The gravity tower in Bremen blends smoothly into the series of possibilities for microgravity experiments, and in the short term, complements them.

08617

### **A330/340 Assembly: New Facility, Technique Described**

*36980211a Stuttgart FLUG REVUE in German  
Feb 88 pp 98-99*

[Article by Helga L. Hillebrand]

[Text] The decision in favor of the program of the airbus twins A330/340 means more than merely an expansion of the product spectrum. For final assembly, Aerospatiale is building a new hall with more modern operational sequences: production lane and dock system combined.

When making a household move, who has not wished at one time or another that the new apartment or the new house could be built around the furniture instead of having to put everything in place laboriously. There a chest just does not fit through the door; here, one or two centimeters are ridiculously lacking for the corner sofa to fit into its niche.

Aerospatiale, responsible for final assembly in the airbus program, will have no such problems when the first Airbus A330/340 moves into its production hall. It sounds somewhat remarkable, but the new hall is really being constructed around the required assembly line.

The existing halls are situated on the Aerospatiale land in St. Martin opposite the Blagnac airport in Toulouse. They are occupied with the A300/310 and the A320. Furthermore, the span of the new airbus twins is too large, so that they cannot be assembled in the A300/310 hall. Thus, when the program for the new models was started in June 1987, a decision was made simultaneously to construct their own special production site.

However, the Aerospatiale land no longer had enough space for this. So a decision was made in favor of a plot of land, 50 hectares in size, in nearby Gramont. The design of the hall became definite on 15 November, because even before the onset of winter, the ground was to be prepared sufficiently for foundation work to begin immediately in March 1988.

The new hall is Aerospatiale's largest: 63 meters long, 58 meters wide, and 17 meters high are supposed to be its dimensions. An interesting metal pipe structure spans the roof of the building. This is also something extraordinary, since usually the metal structure lies in the interior below the roof. The present design is reminiscent of the Centre Pompidou in Paris, which is famous for its extravagant architecture.

### **Delays Can Be Compensated Better**

A point of special importance for the operating sequences is the novel modular structure of the assembly stations. Up to now, one machine after the other was mounted. At the first station, the front section of the fuselage and the tail end were joined to the center segment, at the second station, the wing and tail unit were integrated, then followed several further stations for each new working step. As the aircraft slowly took shape, it thus had to be moved ahead to the next station every few days, in its entirety - an enormous transportation effort which took a great deal of time. Furthermore, a delay in the delivery of one machine propagated to all the following ones.

In the working sequences for the A330/340, Aerospatiale solves this problem by a modular system, which combines the production "lane" of the previous method with the dock system. Movement is necessary only at the first two stations, where the fuselage parts and the wing/tail section are mounted. Then follow three parallel working docks, where the machines remain until final completion. The working sequences thus become more flexible, since delays can be intercepted more easily through the parallel working platforms. Also, these docks have a modular structure, so that they can be used both for the A330 and for the A340 with all possible versions. Thus, a 340 can stand in dock 1, while an A330 is being assembled in dock 3. The machine that is finished first leaves the hall through the large sliding gates.

### First Parts Will Arrive in Spring of 1990.

By the end of 1989, the working equipment must be installed in the new hall, if the schedule for the first A340 is to be adhered to. The first segment will come in the spring of 1990. Finally, the first flight is planned already for the first half of 1991. To maintain these schedules, inasmuch as they affect the construction of the hall, is the responsibility of the Parisian firm Setec, which Aerospatiale chose as the principal contractor for the entire building project.

But this does not mean only the hall itself together with its working platforms. Once assembly is running, 500 to 600 persons will work here. Thus, the building will also contain offices, cafeterias, and all the necessary social facilities. In this way, the A330/340 assembly becomes an independent operation, the "Gramont" plant. This has created good preconditions for the new European long-distance aircraft.

8348

### No Variable Camber Wing for New Airbus Model 36980211b Stuttgart FLUG REVUE in German Feb 88 p 99

[Article by Helga Hillebrand]

[Text] Contrary to the original announcement, the A330/340 will not have a variable camber wing. It appeared that the advantages are not worth the costs.

Now it is for sure: The future airbus twins A330/340 will not receive a variable camber wing. As the partners had planned, the decision was made in the middle of December 1987.

Originally, Messerschmitt-Boelkow-Blohm (MBB), responsible for the low speed area, developed an interesting design for a variable camber wing with the flap system. In this way, it was supposed to be possible to adapt the airbus wing - normally optimized for cruising - also to other flight conditions, for example, take-off, climbing, descending, and landing. This was supposed to increase its economy still further.

British Aerospace, the airbus partner responsible for the air foils, also worked on designs for a high-technology wing with variable camber.

The idea was good, but such a highly complicated wing naturally costs considerably more. Finally, additional control elements are needed in the interior of the air foils to bring the additional flaps always into the correct position. To this must be added further computers and sensors which control the flaps depending on the flight conditions. And these costs must pay for themselves through the advantages of the variable camber wing.

Already in April 1987, Sid Swadling, the chief engineer of British Aerospace in Filton, told FLUG REVUE: "We have to decide whether the variable camber will yield a profit proportional to its costs." This decision was to be made on the basis of intensive studies in the trans-sonic wind tunnel of the Aircraft Research Association in Bedford. Various wing designs were tested here, and the various positions of the variable camber wing were simulated. Calculation of additional costs resulting from more complicated production, greater weight, and more difficult maintenance in line use, spoke against the variable camber wing. Its advantages, connected with lower fuel consumption, were far from compensating this.

The airbus twins thus will be kept aloft by a conventional wing, which will have a very large span. Its span corresponds approximately to that of a Boeing 747, only that the A340 is considerably smaller. But the airbus nevertheless wants to maintain the fuel saving that has been promised to the airlines. With this assurance in their pocket, the airlines should not feel dissatisfied with this decision. In the final analysis, they do not buy an aircraft because of its high technology, which can saddle them only with problems and additional costs in maintenance.

8348

### First Fokker 100 Delivered Amid New Delays, Orders, Financial Questions

#### First Delivery

36980221 The Hague ANP NEWS BULLETIN in  
English 1 Mar 88 p 1

[Text] Schiphol, February 29—Plane-maker Fokker on Monday delivered its first Fokker 100 to Swissair, nearly a year after the original delivery date was repeatedly delayed by production difficulties.

Launch customer Swissair, which has an order for eight Fokker 100s and an option on another six, last year claimed damages because of Fokker's inability to meet the April 1987 delivery date.

At a lavish ceremony neither Swissair chairman Robert Staubli nor Fokker executive Reinder van Duinen referred to their companies' differences over the late delivery.

Staubli said Swissair, which placed its order in 1984, was satisfied it had made a good choice even though the delays had caused some headaches. "Comparing one with the other the positive aspects far outweigh the negative," he said.

All eight of Swissair's Fokker 100s are now set for delivery before the end of this year and two of them would fly on the airline's commercial routes from the end of April, Staubli said.

KLM expects delivery of its first Fokker 100 in September and will fly the aircraft on routes currently served by its DC-9 aircraft. The Dutch airline has already warned Fokker that it will not tolerate any further delays.

Fokker officials at Monday's handing over ceremony said they hoped to reach an output of 33 Fokker 100 aircraft per year by the end of 1989, which would enable them to deliver around 50 orders.

#### Government Aid

Fokker has 87 firm orders in hand, with options for a further 91. Of the 87 firm orders, 40 were placed by the leasing company GPA Fokker 100.

GPA has so far only been able to conclude one leasing agreement for the Fokker 100, but Fokker marketing executive F. van der Jagt said he expected around 20 of the aircraft would be leased eventually.

Van Duinen said he estimated the world market for short- to medium-haul airliners such as the Fokker 100 at 1,000 to 1,200 aircraft by the year 2005, of which Fokker hoped to capture 30 to 40 per cent.

Fokker was forced to appeal for government aid last October when the low dollar and production difficulties threatened to scuttle its two new aircraft, the Fokker 100 and the turboprop Fokker 50.

A joint deal agreed by the government and bankers raised 527 million guilders for the company in exchange for a 49-per-cent government stake and an undertaking to find a merger partner by 1992.

Van Duinen said during the handing-over ceremony that Fokker would not get unnecessarily "nervous" over the effects of a low dollar, which gives its American competitors a sales advantage.

"We are talking about aircraft which will do service for the next 20 to 25 years. The current dollar exchange rate is of a temporary nature," he said.

#### New Delays, Orders

36980221 *The Hague ANP NEWS BULLETIN in English* 3 Mar 88 p 1

[Text] Amsterdam, March 2—Deliveries of the new Fokker 100 aircraft to the KLM and US Air airlines would be further delayed, a spokeswoman for the Dutch aeroplane manufacturer said on Wednesday.

KLM Royal Dutch Airlines would receive the first of 10 Fokker 100s "sometime this year" rather than in September as previously agreed, the spokeswoman said.

KLM was originally due to take delivery of its first Fokker 100 in April.

US Air, which has 20 Fokker 100s on order, would receive its first Fokker 100 at the beginning of next year rather than at the end of this year as originally scheduled, the spokeswoman said.

The spokeswoman said the delays were largely caused by modifications requested by the two airlines.

A spokesman for KLM said the latest delays came as a surprise. KLM and Fokker were discussing how to solve problems caused by the late delivery, he said.

In January the Dutch airline warned Fokker it would not tolerate further delays.

Fokker delivered its first Fokker 100 to Swissair on February 29, nearly a year later than scheduled because of production difficulties.

Neither KLM nor Fokker would comment on compensation for the delays.

#### Air Gabon Orders Fokker 100

Amsterdam, March 2—Air Gabon has decided to modernise its fleet with the new Fokker 100 jetliner, the Dutch plane-maker said on Wednesday.

Air Gabon would acquire its first Fokker 100 in a lease-buy arrangement with Fokker and GPA Fokker 100 Ltd, a joint venture with Guinness Peat Aviation of Ireland and Mitsubishi of Japan.

Air Gabon eventually intended to replace all three of its Fokker F-28 planes with Fokker 100s, Fokker said. The first Fokker 100 was scheduled for mid-1989, it said.

The order is the first for GPA Fokker 100, which in 1986 placed Fokker's biggest ever order for 40 Fokker 100s.

Press speculation last year suggested the order might be under threat because of the volatility of world financial markets.

/06091

#### Dutch Minister on Fokker Financial Straits

36980202 *The Hague ANP NEWS BULLETIN in English* 2 Feb 88 p 3

[Text] The Hague, February 1—Economic Affairs Minister Rudolf de Korte said on Monday he did not expect plane-maker Fokker to solve all its problems this year, but expressed cautious optimism about the company's future.

In a letter to parliament, he said Fokker expected to meet its production targets for the Fokker 100 aircraft in 1988, but that the overall delay in the programme of about a year would not be made good.



De Korte said delays in the production of Fokker's other new plane, the Fokker 50, had affected Fokker 100 production, and that the Fokker 200 test programme had also suffered setbacks.

But this was not surprising considering the complexity of the two aircraft. Experts and independent test pilots were full of praise for both planes, which in many respects were better than their original designs, the minister said.

Fokker had delivered six Fokker 50s in 1987 and received orders for four more. "all in all, the prospects look positive," he said.

De Korte said the delay in delivery of the first Fokker 100 to Swissair was unlikely to affect further deliveries to the airline.

A vital cost-cutting plan for the company was starting to take shape, "which provisionally gives me reason to believe in the achievement of the targets laid down," De Korte said.

The 200-million-guilder-a-year savings plan forms part of a rescue package agreed last October, under which the state will soon take effective control of Fokker.

#### **Government Supervision**

36980202 *The Hague ANP NEWS BULLETIN in English 3 Feb 88 pp 1-2*

[Text] The Hague, February 3—Planemaker Fokker's financial position will not be endangered by delays in deliveries of the first Fokker-100 aircraft, Economic Affairs Minister Rudolf de Korte told members of parliament on Tuesday.

De Korte told parliament's economic affairs committee that compensation to the first two Fokker-100 customers, Swissair and KLM, was "very limited" in relation to Fokker's total cash flow.

The minister said Fokker would work "loyally" to fulfill the conditions of a 527-million-guilder rescue package agreed with the government last autumn, including seeking partners for co-operation.

De Korte did not refer directly to the position of Fokker Chairman Frans Swarttouw during the public part of the committee's hearings on Fokker, but Christian Democrat (CDA) MP Thijs van Vlijmen said this had been discussed behind closed doors.

Swarttouw has been criticised by members of all the main parliamentary parties, who say this leadership is partly to blame for financial and organisational chaos at the company.

However, on Monday Swarttouw said there was no question of him resigning, despite parliament's calls for him to step down.

De Korte said the main duties of a new three-member advisory board would be to advise the executive board on "strategic issues" and advise the supervisory board on a fourth executive board member.

He said the advisory board, one of the government's conditions for extending state aid, would not operate under a statute as originally planned, as the members themselves did not feel this was necessary.

Asked about supervision of Fokker's affairs, De Korte said the Netherlands Aerospace Institute (NIVR) would report to him every three months on the state of orders and production.

The National Investment Bank (NIB) would report on the company's finances, while the General Audit Chamber would have access to information on all aspects of Fokker's affairs.

Asked about Fokker's cost-cutting agreements with project partners NBB of West Germany and Shorts of Northern Ireland and about negotiations with unions to cut 1,730 jobs, De Korte's replies remained vague.

Fokker is committed to cutting costs by 200 million guilders a year, 100 million in labour costs and 100 million under arrangements with suppliers and project partners MBB and Shorts.

Under the rescue package the government will shortly take effective control of Fokker through a share issue which will give it a 49-percent stake in the company.

/9274

#### **Italian Senate Approves Bill on Italian Space Agency**

36980196 *Rome ANSA in English 1048 GMT 4 Feb 88*

[Text] Rome, 4 Feb (ANSA)—The Italian Senate has approved a bill to create an Italian Space Agency to set up a national space plan over a five-year period, to send Italian astronauts on space missions, and to oversee Italian participation in European projects regarding spaceships and orbiting stations.

With passage of the bill "an Italian NASA has been born," said Undersecretary for Scientific Research Learco Saporito.

He said the new body would be based in Rome and placed under the direct supervision of the Scientific Research Ministry.

The bill must now go before the Chamber of Deputies.

/9274

## BIOTECHNOLOGY

### EC Fine Tunes Biotechnology Regulations, R&D Program

#### Results of EC Conference on Regulations

3698m198 *Brescia BIOTEC in Italian*  
No 6, Nov-Dec 87 p 60

Article by Maria Rosa Cattadori: "What is the Current Status of Regulation?"

[Text] September and October were busy months for the debate on safety, regulation, and environmental impact as related to biotechnology. On 16-17 September the "EC Regulatory Harmonization of the Deliberate Release of Genetically Engineered Organisms" was held in Cervia. Soon after, on 7-9 October in Geneva, the "First Ad-Hoc Meeting on Guidelines on Safety in Biotechnology" took place. Although slightly different in nature, both these meetings showed the indisputable need to reach a reliable evaluation of the risks and the definition of regulations concerning the genetic manipulation of living organisms. The first meeting dealt specifically with the directive on the deliberate release of engineered organisms (GMO) (a summary is published on the following page) [not shown] put forward by the DGXI (Environment [Department]) of the European Community Commission, and its applicability was discussed with representatives of corporations, governments, and the press of the nations participating in the workshop. The aim of the second meeting, broader in scope, was to examine the safety directives proposed by the Chemical Industry Committee of the United Nations European Economic Commission.

On conclusion of the first workshop, organized by the Institute for European Environmental Policy, which was of a purely informative nature, several points emerged giving rise to lively debate. However, unofficially it is felt that the directive, which should be discussed by the Community early in the new year, probably will not be approved by the member countries because of the considerable opposition shown by industry. The Research and Development Division, the DGXII, would like to see more complete regulatory measures approved. It is feared that a directive of this kind may slow down and interfere with scientific and industrial progress.

The following aspects were the ones discussed at greatest length during the congress:

1—It is necessary to concentrate on the "effects" and, therefore, to regulate not only engineered organisms but also (proposed by Dr Frontali of the Higher Institute of Health) spontaneous mutants and conventional branches. To accelerate the procedure, the DGXI proposes that regulation of the first category be dealt with first.

2—"General" permission cannot be granted for the release of micro-organisms; an evaluation of each case is necessary, according to OECD directives, while still leaving individual nations free to apply even more restrictive regulations at the domestic level (as in Denmark).

3—Continuous monitoring is necessary even after release into the environment.

4—The organization of a database to record all release experiments, whether completed or in progress, is essential, initially at EC level and subsequently at OECD level, and in future at United Nations level.

5—There must be public debate both on the regulations and on the implementation of experiments, with responsible reporting on the part of the mass media, which must also collaborate with the institutes carrying out the research.

6—Parallel research for risk evaluation must also be conducted.

On the other hand, the Geneva meeting organized by the Chemical Industry Committee of the United Nations was preceded by two meetings in May 1986 and February 1987, after which opinion polls were carried out in the industrialized European countries on the current regulatory situation for environmental applications of GMO. In the light of this survey and of discussions arising during the meetings, the participants at the congress agreed that:

- The need for regulatory measures is evident, given that only very few countries have them today.
- The available information indicates that the national legislations cover different aspects, and it is therefore necessary to harmonize them in a European framework.
- The Chemical Industry Committee can act as coordinator, particularly between socialist countries and the other industrialized European nations. While awaiting more complete information on the regulatory measures in East European countries—which met to discuss these aspects last June—the committee, working together with international organizations and members of the United Nations such as WHO, UNIDO, and UNEP [United Nations Environment Program], will not take any further action.

08627

### R&D Program Revised

3698m232 *Bonn TECHNOLOGIE*  
*NACHRICHTEN-MANAGEMENT*  
*INFORMATIONEN in German No 472, 29 Jan 88 p 12*

[Text] A review of the EC research program in biotechnology (1985-1989) has been proposed to the council by the EC Commission. The program, as the Commission emphasized, has so far not proved to be adequate for the organization of an international cooperative network. This association is organized in such a way that it can

study the various consequences and assess the different risk levels deriving from the application of biotechnology in agriculture, industry, and environment. Therefore, the Commission claims that an additional 20 million ECU are required for the intensification and expansion of the program. The following are the planned extensions of the current program in detail:

**Review of the Pluriannual EC Research Program in the Area of Biotechnology.**

**(1985-1989)**

—Intensification of current research efforts in the program section concerning the assessment of risks related to modern biotechnology, especially with regard to the planned release of organisms modified by genetic engineering.

—Intensification of current research efforts in the area of information technology with particular emphasis on data processing related to collection of micro-organisms, cell cultures, genome sequences, and enzyme technology.

—Intensification of ongoing activities (visits, publications, electronic data networks, congresses, summer workshops, etc) with the objective of adequate dissemination of information regarding the program and research achievements. Involvement of EC industry in research activities and in the utilization of data, materials, and methods resulting from contracted research.

—Studies and pilot projects preparing future joint R&D activities in the area of biotechnology during the period 1990-1994.

—Intensification of training activities in all sections of ongoing programs.

—Adaption of means (manpower) for concerted activities to the requirements defined in the contract.

—Extension of all program activities to Spain and Portugal.

08617

**Italy, France Hold Biotechnology Meeting**  
*3698m196 Brescia BIOTEC in Italian*  
*No 6, Nov-Dec 87 p 59*

[Text] Organized by the French Foreign Trade Center and the French Embassy, a French-Italian Biotechnology Technical Workshop took place in Milan on 26 and 27 October.

The aim was to introduce the most important French groups and companies in the field to the Italians operating in the health and agroindustry sectors of biotechnology. Twenty French companies were present, with stands illustrating their activity and reports given by their

representatives to the Italian audience. Jean-Pierre Raynaud, president of ARIBIO (Association for International Research in Biotechnology) and innovation director of the Roussel Uclaf company, opened the proceedings by presenting the French biotechnology program which, after being launched in 1981, was restructured in 1985 with the creation of a board and a program management body operating in four committees: agroindustry microbiology, biotechnology and health, data processing, and international problems. The French, who are strong in fields such as enzymes and enzymatic sensors, and weaker in areas like product extraction and purifying, can nonetheless rely on a basic research system that is less fragmented than that of Italy, and on a number of young biotechnology companies at international level. An entire afternoon was dedicated to the culture of animal cells, and another to diagnostics; other subjects covered were vaccines, biomaterials, and the production of polysaccharides and lactic ferments.

Italy is seen by our French neighbors as a good potential area both for the development of possible joint ventures and as a market for biotechnology products and instruments.

08627

**State, CNR-Sponsored Biotechnology, Genetic Engineering Work in Italy**

**Biotechnology Projects Sponsored**  
*36980190e Milan BIOTEC in Italian May 87 p 58*

[Article by Maria Rosa Cattadori: "Biotechnologies and Bio-Instrumentation Targeted Project"]

[Text] The request-for-participation forms relative to the Biotechnologies and Bio-Instrumentation Targeted Project have been printed and distributed. They are available at the office of the CNR [National Research Council] in Rome and the research areas of the CNR in Milan and Naples. The requests together with relative research programs coming under the sectors covered by the Project must be submitted by 10 November 1987.

The Biotechnologies and Bio-Instrumentation Targeted Project represents the merging of the two pre-feasibility studies relative to Biotechnologies and Bio-Instrumentation respectively.

The two studies have the common aim of developing capabilities with respect to topics in the realm of the biological sciences, that would enable improvement of production and use of our country's own resources.

The areas of research around which the project is structured have been carefully chosen avoiding topics that would have entailed strong foreign competition and selecting those best lending themselves to maximum exploitation of the capabilities of Italian researchers.

Sectors already included in long-range CNR programs were purposely ruled out and an effort made to complement them with closely related Strategic Projects. The Project referred to herein comprises seven subprojects—only one of which is devoted to biological instrumentation—and is centered on the development of biotechnologies and technical applications specific to the public health sector.

#### **Molecular and Cellular Engineering Subproject**

Development of genetic, chemical, and physicochemical methodologies enabling the targeted manipulation of proteinic structures by means of specific situs mutagenesis, to obtain diagnostic enzymes, or pharmaco-enzymes, or proteins of predetermined antigenicity and stability.

Biochemical characterization of extremophilic microorganisms, with particular reference to thermophiles.

Expression of extremophilic enzyme genes in mesophilic microorganisms.

Biochemical engineering for the construction of new cytotoxic medicinals and antimetabolites, and for the study of natural and synthetic factors of pharmacological interest and the definition of their relative actional mechanisms (growth factors, chemotactic factors).

#### **Innovative Vaccines and Biodiagnostics Subproject**

Nucleic acid probes for the diagnosis of diseases caused by infective agents, study of genic frequencies in the population and non-radioactive labeling methods.

New techniques for the production and purification of monoclonal antibodies specific to infective and degenerative diseases, and of engineered antibodies, and development of vectors and cells for their expression. New technologies for the use of monoclonal antibodies: In vitro immunodiagnostic systems, and new systems for detection, for evaluation of clinical immunodiagnoses, and for use of antibodies as vectors for in vivo diagnosis and therapy.

Development of new recombinant, synthetic human and animal, and anti-idiotypal vaccines. Recombinant antigens for diagnosis.

#### **Innovational Fermentation and Bioconversion Processes Subproject**

Production of recombinant proteins in microorganisms: Development of cloning technologies for industrial applications, research on the physiology of growth in engineered microorganisms, improvement of fermentation processes.

Use of engineered microorganisms for the elimination of polluting substances.

Optimization of bioreagents: Immobilization of enzymes, antibodies and cells.

#### **Biosensors, Cellular Vehicles and Bioreagents Subproject**

Development of in-vivo-implantable biosensors for the monitoring of hematic and tissual parameters.

Characterization and use of cellular vehicles for human and veterinary applications.

Construction of biological membranes, liposomes and other artificial systems for the controlled administration of medicinals.

#### **Applications of Biotechnologies and Cellular Cultures and Organ Transplants Subproject**

Optimization of mammal cell culture techniques, and of those relating to human keratinocytes for the treatment of very severe burns.

Cellular line banks for the diagnosis, prevention and therapy of degenerative and dysmetabolic diseases.

Biotechnologies and organ transplants.

#### **Biomedicinals Subproject**

New pharmacologically active factors: Improvement of production technologies.

Actional mechanism of medicinals and of growth factors in vivo and in vitro.

Genetic modifications in vivo (transgenic animals).

Development of new antibiotics (hybrid antibiotics, proantibiotics).

Plasma fractionation technologies.

#### **Bio-Instrumentation Subproject**

Development of systems for the analysis and characterization of cells, computerization of diagnostic methods with DNA probes and development of instrumentation for the study of DNA, enzymatic reagents, analysis of biological, chemical, and physical parameters of waters.

A total of 140 operational units will participate in the program, 85 of which will be financed by the project and 55 by third parties.

Overall funding by the CNR will total 84.4 billion lire. Various sources will provide an additional 60 billion lire. Researchers and specialized personnel awarded scholarships, training contracts or other forms of contracts will total 129.

### Conclusions of Genetic Engineering Project Presented

3698m197 Brescia BIOTEC in Italian  
No 6, Nov-Dec 87 p 58

[Text] The conclusions of the finalized project "Genetic Engineering and Molecular Bases of Hereditary Diseases" (1 July 1982-30 June 1987) were presented in Pavia at the CNR [National Research Council] Institute of Evolutionary and Biochemical Genetics. Prof Arturo Falaschi, director of the project, described the results achieved to the press and asked professors Glauco Tocchini Valentini, Francesco Blasi, and Antonio De Flora, in charge of the subprojects "Genetic Engineering," "Cellular Biotechnology," and "Molecular Bases of Hereditary Diseases," to explain the more specific sectors in which the project has influenced the approach and training of the new ranks of Italian biotechnologists. He also asked them to explain what CNR research is able to offer industry today to be able to continue work in a field that should, in theory, offer at least some production outlets.

The discussion dealt with mechanisms of genetic expression, the cloning of genes that codify for certain proteins, mechanisms of neoplastic transformation, diagnostic methods for hereditary diseases, and a data bank. It emerged clearly that the first and most important objective reached has been the consolidation of know-how in this field in Italy—even though this has been done with a certain delay—which universities alone would have been unable to provide.

However, a certain anxiety was felt concerning how and when the "second-generation" project could be continued and how this will link up with the finalized "Biotechnology" project and the strategic "Human Genome" project. There is also concern on account of the time that elapses between the presentation of a project and its effective launch with the relative funding being made available; this certainly cannot be considered competitive compared to the timing that the acceleration in biotechnological research has imposed in other industrialized countries. More studies could have been done, and more rapidly; however, something positive has been achieved, which is the conclusions drawn from the Pavia meeting.

08627

### Overview of National Biotechnology Program

36980190d Rome NOTIZIE AIRI in Italian  
Oct 87 pp 21-23

[Article: "National Biotechnologies Program: Decrees Published"]

[Text] The national advanced-technologies research program, which was approved by the CIPI [Interministerial Committee for Industrial Policy Coordination] last May

(the relative proceedings were published in the GAZZETTA UFFICIALE No 148 of 27 June) with funding of 209 billion lire, has entered its implementation phase. The minister for scientific and technological research has in fact signed the decree (published in the GAZZETTA UFFICIALE No 169 of 22 July 1987) setting forth the specific targets of the research covered by the program, the timetables and expenditures, and the terms and conditions that will govern the future awarding of research contracts.

The National Program is structured around three major areas:

- medicine and veterinary science;
- chemistry, energy and environment;
- agriculture and food processing.

For the three areas, the decree sets forth the topics on which research is to be based, a summary listing of which follows:

#### Medicine and Veterinary Science

**Topic 1:** Monoclonal antibodies for diagnostic use (maximum expenditure on research not to exceed 7 billion lire; maximum duration not to exceed 48 months);

**Topic 2:** Nucleic acid probes (expenditure not to exceed 8 billion lire; research to be completed within 60 months);

**Topic 3:** Plasmatic proteins characterization and separation technologies (duration 60 months; maximum expenditure 20 billion lire);

**Topic 4:** Fibrinolytic enzymes modified by means of DNA technologies (duration 60 months; expenditure 12 billion lire);

**Topic 5:** Technologies for the synthesis and post-translational modifications of polypeptides of pharmacological interest (duration 60 months; expenditure 18 billion lire);

**Topic 6:** Monoclonal antibodies for immunotherapy (duration 60 months; expenditure 13 billion lire);

**Topic 7:** Immunotoxins and other conjugates for therapeutic use (duration 60 months; expenditure 10 billion lire);

**Topic 8:** Biologically active microbial metabolites (duration 60 months; expenditure 11 billion lire);

#### Chemistry, Energy, Environment

**Topic 9:** Enzymes with new properties (duration 60 months; maximum expenditure 13 billion lire);

**Topic 10:** Bioconversion processes and enzymatic catalyses for the production of fine-chemical intermediates and/or products duration 60 months; expenditure 18 billion lire);

**Topic 11:** Polysaccharides from natural sources (duration 60 months; expenditure 15 billion lire);

**Topic 12:** Biological degradation of sludges and oily residues generated by the petroleum and petrochemical industry (duration 60 months; expenditure 7 billion lire);

**Topic 13:** Biological treatment of the effluents generated by the dairy and cheese industry (duration 48 months; expenditure 5 billion lire);

#### **Agriculture and Food Processing**

**Topic 14:** In vitro regeneration of plants from protoplasts and cells (duration 60 months; expenditure 9 billion lire);

**Topic 15:** Introduction and expression, in plants, of exogenous genes (duration 60 months; expenditure 9 billion lire);

**Topic 16:** Nitrogenous metabolism of industrial crop plants (duration 60 months; expenditure 15 billion lire);

**Topic 17:** Enzymes for the food industry (duration 60 months; expenditure 11 billion lire);

**Topic 18:** Technologies for evaluation of safety of use of foods (duration 36 months; expenditure 5 billion lire);

**Topic 19:** Technologies for evaluation of freshness of foods (duration 36 months; expenditure 3 billion lire).

Bids for awarding of contracts must be sent to the Office of the Minister for Scientific Research not later than 30 November 1987.

9238

#### **BMFT Subsidies for Medical Biomaterials Research Announced**

3698m212 Bonn *TECHNOLOGIE  
NACHRICHTEN-MANAGEMENT  
INFORMATIONEN* in German No 471, 15 Jan 88 p 6

[BMFT Announcement of subsidies for R&D projects in the area of biologically active and biocompatible implants and materials (biomaterials); dated 17 December 1987]

[Text] As part of the program, "R&D in the Service of Health," the federal government is subsidizing work to develop, test, and evaluate biologically active and biocompatible implants and materials that come into long term contact with body tissue and body fluids, in this

case, with blood in particular. These implants and materials must maintain their function in the long term, must not be toxic, must not trigger immunological reactions, must not be attacked by body fluids, and must not trigger significant metabolic changes in the contact zone.

The organ support functions of artificial implants play a significant role in surgical care and transplant medicine, not only regarding continuous long-term use, but also with their bridging function for the pre-operative and post-operative stabilization of the patient during natural [organ] transplantation. For example, the high number of kidney transplants would not be imaginable without the bridging function of the "artificial kidney."

Research and development projects on this topic have already been subsidized as part of the program on biocompatible materials, announced on 9 March 1981.

So far, the outcome of these subsidy measures has yielded practical results notably in the development of biomaterials that come into short-term contact with blood, such as blood bags and tubular systems.

However the development of other biomaterials for long-term use has not yet reached a stage at which an early application of the results in public health care is in sight. Among other things, significant knowledge regarding the basic interaction processes between implant and blood still must be acquired. Therefore, the 18 March 1985 announcement of the priority subsidy program, "Biomaterials and Hemocompatibility" emphasized a stronger orientation toward basic research work.

In parallel to this, the current subsidy structure must be expanded through continued subsidy of application oriented R&D projects and the application of basic research results must be accelerated.

The following topics in particular are to be subsidized:

1. R&D work to improve heart and lung machines, particularly the oxygenators in view of minimized cell damage and low impact on the coagulation system.
2. R&D work for the ad hoc development of long-term compatible vascular replacement, with special emphasis on veins and small lumen [Kleinelumigen] arteries.
3. R&D work on innovative heart valve prostheses and optimization of existing heart valve prostheses while avoiding destructive processes such as calcification.
4. Development of improved membranes for oxygenators, both for pharmaceutical plasmapheresis and for selective diffusion of implantable sensors.
5. R&D work with the objective of simulating the natural boundary layer with body tissues by coating biomaterials with active molecular or cell layers, such as the induction of a neointima for artificial vascular replacement.
6. R&D work to develop implantable hormone and drug dispensers including therapeutic catheters [Verweilkatheter].

Subsidies are available for the development and optimization of simple and clear in-vitro, ex-vitro, and in-vivo test methods which are closely related to the testing and evaluation of individual results of the above-mentioned development goals.

Subsidized research must normally be conducted in close cooperation with clinical, technical, and industrial partners.

For projects planning a broad utilization of R&D results and eventual product marketing, applications are usually made through a company.

Research proposals must be directed to the project contractor, The Society for Radiation and Environmental Research mbH in Munich. A direct contact with the project office is recommended prior to a formal application.

08617

## COMPUTERS

### EC Issues Fourth Call For ESPRIT Bids

3698m211 Bonn *TECHNOLOGIE*  
*NACHRICHTEN-MANAGEMENT*  
*INFORMATIONEN in German No 471, 15 Jan 88 p 9*

[Text]

#### 1. Background

The Commission hereby publishes the fourth call for bids for the European strategic R&D program in the area of information technologies. The first phase of this program was inaugurated in 1984 by the Council's resolution 84/130/EWG. Several other related calls for bids were published, drawing over 1,200 proposals. This led to the establishment of 220 R&D projects, with a total cost of 1.5 billion ECU, on which approximately 3,000 specialists are working at present. Independent consultants examined the program on behalf of the Commission and confirmed its viability, and the majority of ongoing projects already show useful results.

Encouraged by the momentum and success of the first phase, the Commission began planning for the second phase of ESPRIT in 1986. This will include the following work, concentrated in three strategic areas:

- microelectronics and technology of peripherals;
- information processing systems;
- technologies for IT [information technology] applications.

This work has been described in the "ESPRIT work program," dated 22 July 1987.

In a meeting on 21 December 1987, the Council of Ministers, in cooperation with the European parliament, established a common viewpoint regarding the Commission's proposal. The final decision of the council is expected by the first quarter of 1988, after the second reading in the European parliament. In order to promote a rapid implementation of the program, and confident that all required documentation from the interested organizations for the preparation of their proposals is now available, the Commission has decided to publish the fourth call for ESPRIT program bids.

#### 2. Conditions for Tendering

Bids with the following contents, and fulfilling the following conditions are solicited:

- Projects involving pre-competitive industrial R&D cooperation;
- Projects referring to proposals and thematic areas described in the ESPRIT work program;
- Those complying with the rules described in the information package accompanying the fourth call for bids within the framework of ESPRIT 1987;
- The forms and procedures described in this information package (as amended 15 December 1987) are to be used;
- The work and results of the first phase of the ESPRIT program must be taken into account whenever possible;
- Bids must take into account the proposed project's relation with the work of other national or international programs, and the planned cooperation mechanisms, concerning related activities which have already started or will start soon.

#### 3. Limits of the Fourth Call for Bids

It is expected that the total cost of the projects resulting from this call for bids will amount to 1.2 billion ECU (half of which will be provided by the EC). The contracts offered to the proposing parties usually extend over the first two or three working years of the project and can be extended if successful, provided the project retains its importance to the ESPRIT program. For very large projects, including TIP's, the initial contract is usually valid only for the definition phase or the first working year.

This call for bids does not include basic research activity, which is planned for the second phase of the program. A separate call for bids will be issued in this respect at the beginning of 1988.

#### 4. Contents and form of proposals

Details regarding the form and contents of bids are contained in the information package. This package includes background information and instructions to ensure that the applicants provide all information required by the consultants. This will enable them to fully evaluate the quality and worth of a given proposal with regard to the specific goals of ESPRIT.

Based on the experience gained in the first phase of the program, and taking into account the long period of time that has elapsed since the first call for ESPRIT bids, strong competition can again be expected among the various associations that will submit proposals for the projects which are described in detail in the work program. Applicants are therefore encouraged to submit only fully developed proposals which meet all the criteria cited in the information package.

In general, proposals for large-scale projects (requiring more than 100 man-years of R&D) must:

- demonstrate that the work starts from a clearly defined basic line;
- clearly describe the objectives and technical concepts according to which major advances can be made, as opposed to currently-available industrial technologies;
- demonstrate a management structure and mode of operation suitable to reach the stated objectives;
- demonstrate a suitable mix of partners in terms of their credibility and level of involvement;
- identify relevant intermediate results and overall surveys that can be used to evaluate progress;
- describe, and as far as possible quantify the results expected during the course of the work;
- demonstrate how the industrial competitiveness of the project participants is enhanced on the world market by the results of the work.

Bids for smaller or more speculative projects must consider these conditions in a manner suitable to their subject area and objective.

As in the first phase of ESPRIT, there are plans to have small and medium-sized companies participate in all types of ESPRIT projects. To further enhance the role of KMU's [small and medium-sized companies in ESPRIT, they will also participate to a large extent in very large-scale R&D projects (including TIP). Very large-scale projects are those which require more than 300 man-years of R&D. For this reason, the related proposals must contain clear-cut specifications for the tasks and the amount of work expected from the KMU's. It is understood that some KMU's do not wish to participate in very large-scale projects as a prime contractor. The proposal should therefore include the prospective contractual basis for cooperation, that is, as prime contractor, associated partner, or as subcontractor.

Proposals for large-scale projects of this kind must contain program plans with defined stages and work phases consisting of approximately 1 year period, permitting both gradual completion of work, and the approval of prospective contracts.

#### 5. Information for Applicants

In drafting a proposal, interested parties may refer to the following documents:

- this call for bids;
- the ESPRIT work program dated 22 July 1987;

—the 1987 information package (amended 15 December 1987).

These documents have already been distributed in large quantities. Further copies may be requested from the address below. Minor changes in the work program are listed in paragraph 9 of this call for bids.

As far as possible, applicants should also consult the description of ongoing ESPRIT projects, called "synopses," also available from the address given below. Further information is available in the reports of the annual ESPRIT meetings, available under the titles ESPRIT 84, ESPRIT 85, ESPRIT 86, and ESPRIT 87 at local EEC document offices.

A copy of the standardized contract used for projects participating in the second ESPRIT phase is also available from the address below. A general description of the contract conditions is already included in the information package.

These documents will be familiar to those already cooperating in the ESPRIT program, but in an improved form. However, like first time applicants, those individuals should request a full set of documents and study them carefully, to ensure that their proposals have the best chances for success.

Prospective applicants may also use the EUROKONTAKT system, a database available to the public with information on organizations that are seeking partners for R&D work.

The EUROKOM system for electronic mail and conference services is also available as an electronic communications medium to all parties interested in ESPRIT themes.

Information on EUROKONTAKT, EUROKOM, and the conditions for the use of these services is also available from the address below.

#### 6. Deadline for submissions

The format and procedures for submission of proposals are contained in the information package.

The deadline for submissions is 12 April 1988 at 17:00 hours.

At present, the proposals must be sent to:  
Commission of the European Community GD Telecommunications, Information Industry, and Innovation  
Office of ESPRIT Proposals A 25  
Rue de la Loi 200  
B-1049 Brussels

The Commission reserves the right to disregard any proposals arriving after the deadline.



## 7. Notice to Those Intending to Submit a Proposal

Anyone wishing to submit a proposal is requested to communicate his intent as soon as possible, and, in any event, no later than 15 February (see page seven of the information package). Details may be found in paragraph I.2 of the information package.

**8. Further information can be obtained from:**  
Commission of the European Community GD Telecommunications, Information Industry, and Innovation  
Office of ESPRIT Management A 25-7/11  
Rue de la Loi 200,  
B-1049 Brussels

**9. List of Typographical Errors in the Work Program**  
p.I-28 Time schedule: replace "will" by "should."  
p.III-27 Last line in the project description III.2.2.1 cancel: "Years 6 and 7: Tests and Evaluation."  
p.III-27 Last line in the project description III.2.2.2 cancel: "Years 6 and 7: Tests and Evaluation."

The work plan dated 22 July 1987, including the typographical errors listed above, and the 1987 information package for the fourth call for ESPRIT bids (amended 15 December 1987) form the final edition of the documents relating to the call for bids.

08617

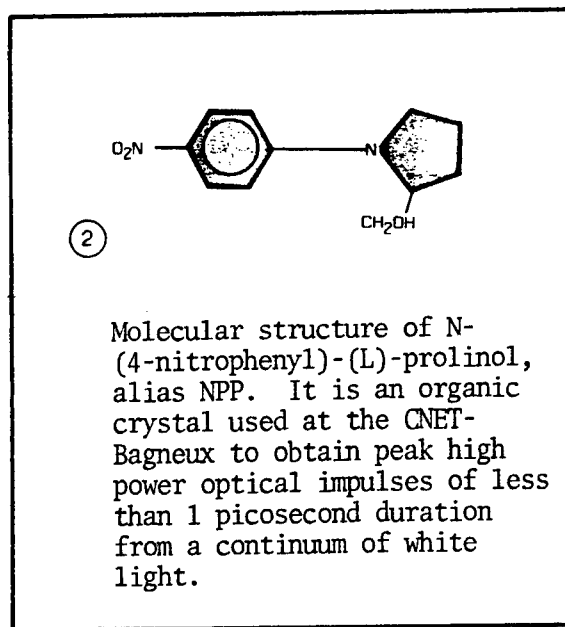
**Trends in Optical Computer Research in France**  
36980183c Paris *ELECTRONIQUE INDUSTRIELLE*  
in French 1 Feb 88 pp 58-62

[Article by Gilbert Rhemes; first paragraph is *ELECTRONIQUE INDUSTRIELLE* introduction]

[Excerpts] Possible now is augmentation of the computing power of computers and parallel processors! By means of optic networks interconnecting processors whose function is the processing (and why not optic processing?) of the data. These networks make use of the nonlinear interactions of light with matter.

The advent of optical computers is going to unbolt several technological "lockups." Instead of exploiting electrons in the customary manner, they will be used to modulate light. Instead of striving as at present against the barrier of the nanosecond, optics will jump straightaway to the level of the picosecond, indeed to the environs of the femtosecond.

"The principal approaches at present involve semiconductors; that is, those of the III-V family, integrated or of the multiple-quantum-wells type, or those of the II-VI family, or even silicon....," says P. Chavel, of the Institut d'Optique at Orsay, in *REVUE DE PHYSIQUE APPLIQUEE*, which in 13 articles in its October 1987 issue addresses optical functions in the computer, "... but mention should also be made of photorefractive materials which include—besides certain semiconductors that have already been mentioned—



lithium niobate crystals in particular, and oxides of bismuth-silicon and of bismuth-germanium; in addition, some hopes are being placed in organic materials of the delocalized  $\pi$  electron type."

Delocalized  $\pi$  electrons are the topic of studies by P.A. Chollet, F. Kajzar, J. Messier, J.M. Nunzi, and D. Grec. at the IRDI [Saclay Center for Nuclear Studies]. These electrons are localized in semiconducting organic polymers (polydiacetylenes and polyacetylenes, polythiophenes), which are well known for their nonlinear, fast response times (less than a nanosecond). This property is owing specifically to  $\pi$  electrons, which are far more polarizable than classic, valence-bond electrons. "Although optical bistability at high energy levels is thought to be achievable, no specific experimental work has been done in this domain," say the IRDI researchers. "Infrared-induced variations of absorption could lead to fast optical valves."

At the CNET [National Center for Telecommunications Studies] at Bagneux, the research being done by Joseph Zyss and Isabelle Ledoux is centered on molecular organic layers, and is oriented towards electro-optical modulators and components, and parametric amplifiers. It is in this regard that the behavior of a new organic crystal, the NPP, has been analyzed at 1.44  $\mu\text{m}$ . A material such as this could be used for infrared signal processing devices, the potentials in this regard are still largely unexplored (Fig 2).

It is noted that an Esprit project on organic materials characterized by a high degree of nonlinearity currently

links several European laboratories (including that of the CNET, but also the Thomson Central Research Laboratory) doing research in this field.

At the same CNET laboratory, J.L. Oudar is doing research on semiconductive structures of the III-V family, with a view to developing bidimensional networks of the planar-structure type, capable of building integrated optic gates into matrices with pinpoint accuracy. These structures are obtained by photolithography of epitaxial layers of AsGa and AlGaAs some 100 or so Angstroms—that is, several tens to several hundreds of atomic planes—thick, and are known as quantum wells (or quantum multi-wells, or even as super-networks) of the exciton type. Such a structure comprises a periodic arrangement of ultra-thin layers alternated with two different alloys or semiconductors. This alternance of layers is overlain by the appearance of potential wells that affect the properties of the particles (positive holes and electrons) in the vicinity of these networks. The CNET's research program, which got under way exactly 1 year ago, is centered on, first of all, analyzing their nonlinear optical properties in the presence of high intensities generated by semiconductor lasers at a wavelength of 0.85 gmm. The instrumentation proves easier to set up and operate at this wavelength than at 1.3 or 1.55 gmm. Later, however, plans call for changing to longer wavelengths with a view to building optic-fiber switching matrices.

Exciton states are also being studied by the team of J.P. Pocholle and C. Puech at the Thomson Central Research Laboratory: "The optical properties of quantum-well structures have been actively explored with the aim of realizing optical-logic functions (bistability), spatial modulation (free propagation), and fast guided-propagation modulation."

#### Sights Set on Femtosecond!

The team spirit that reigns at the [joint] Applied Optics Laboratory of ENSTA [Higher National School of Advanced Techniques] and the Ecole Polytechnique, headed by Alain Orszag and Andre Antonetti, is motivated by the fact that this laboratory is participating in the world race to attain the femtosecond. The producing of laser pulses of  $10^{-15}$  second duration is in fact one of the major objectives of some 20 American laboratories! The work of this Palaiseau team is a benchmark in this speed race.

Pursuing its research, the Palaiseau team has recently discovered the optic Stark effect: "The electromagnetic field of the incident light wave can itself produce optical modifications without requiring that the light actually be absorbed by the medium it traverses." The perturbation persists as long the light wave is present in the medium, and disappears with the end of that presence. This mechanism has been applied to the realization of an optic gate which switches then returns to equilibrium in several hundred femtoseconds!

For their part, Gerald Roosen, Gilles Le Saux, and their Ecole Supérieure d'Optique colleagues are devoting their attention to the photorefractive effect in bismuth-silicon-oxide (BSO:  $\text{Bi}_{12}\text{SiO}_{20}$ ) and bismuth-germanium-oxide (BGO:  $\text{Bi}_{12}\text{GeO}_{20}$ ) crystals. The photorefractive effects found, with even greater sensitivity, in semiconductors (GaAs : Cr, InP : Fe, undoped GaAs), than in BSO, lend themselves to contemplating the possibility of optic data-processing in the near infrared.

#### Optic Data-Processing

"Although nonlinear optics and the filtering of spatial frequencies have few if any common points of departure, they converge today in a common aim to introduce optics into the computer," says P. Chavel.

Hence, the advent of the first spatial light modulators, still being defined as: Optic valves, components compatible with present technologies, capable of modulating the transmission or reflection of an image in response to an optical or electrical command.

In the classifying of modulators, a distinction is made between unidimensional modulators (acousto-optic volume modulators, electro-optic modulators, or acousto-optic modulators of the integrated optics type) for tridimensional or guided-wave optic systems, and optically- or electronically-addressed bidimensional modulators (coherent imagers). A distinction is also made among analog, binary, and nonlinear modes of operation... "The principal development is the growing use of microelectronics," notes G. Lebreton, commenting on the convergence towards technologies compatible not only among themselves, but also with analog and digital electronics.

An example is provided by ONERA at Toulouse, where a multi-discipline team from the data processing and optics departments has set out to introduce optical techniques into paralleled-computer architectures. "Data processing machines of the centralized-structure type have inherent traffic-jam problems on data transmission lines," explains D. Comte, and "the distribution of tasks among several independent modules palliates that situation." A good palliative, to be sure, but only if each of the modules is a powerful electronic processor equipped with local memory. ONERA is studying the linking of processor networks, and in this instance INMOS Transputers, to one another by a configuration of programmable communications nodes. There remains nevertheless the telecommunications problem, which electronics is at a loss to resolve.

"Our objective is to proceed directly to communications within this massively paralleled architecture," D. Comte told us. Optics enables communication at high speeds (several gigabits) over a large number of channels (1,000

channels, for example) that can be configured according to requirements (assuming a reconfigurable system). The idea is to be able to select the transmitter that, linked to the proper receiver, will best fulfill a given range of required functions. D. Comte adds, "The sole network offering the full range of connection possibilities between any two subscribers, without conflicts, is the crossbar type." The optical crossbar switch used by ONERA is a liquid-crystal valve manufactured by Hughes. It consists of a succession of thin layers. A dielectric mirror and a blocking layer provide optic isolation of the read and write beams.

A "breadboard" model is being assembled, with an architecture based on eight T414 Transputers (hence eight systems, each providing four output channels, each channel equipped with an electroluminescent diode), and an optical crossbar network providing 35 channels for connecting 35 transmitters to 35 receivers (photo-diode arrays in this instance) in any way whatever by means of single-mode optic fibers.

According to G. Roosen (Institute of Theoretical and Applied Optics) and P. Gravey (CNET-Lannion), the holographic approach to reconfigurable optical interconnections is also characterized by a large number (1,000) of inputs and outputs, and a speed of reconfiguration that permits the modifying of some 10 connections per second. Deflection of the beams propagates freely between an input matrix and an output matrix, is provided by a matrix of erasable holographic recording cells [this passage as published]. Photothermoplastics are being studied in this regard at the CNET, and photorefractive crystals at the Thomson Central Research Laboratory and the Institut d'Optique. In the first case, the recorded diffraction networks are thin; in the second, they are thick.

9238

#### **Report Assesses State of French Supercomputer Technology**

36980183a Paris *ELECTRONIQUE ACTUALITES* in French 12 Feb 88 pp 1, 4

[Article by J.-P. Baranes; first paragraph is *ELECTRONIQUE ACTUALITES* introduction]

[Text] The report of the commission known as the Caseau Commission, on supercomputers, has now been submitted to the General Directorates of the Ministries of Defense, Industry, and Research. This report assesses the state of French industry in this sector and endeavors to point out the orientation that appears to offer the most promise for it. The report finds that as of today a capability exists in the field of so-called supercomputers, particularly in the case of industrial teams—Bull as well as Thomson Simsa Sintra—a capability that in 1980 was

nonexistent. For the future, the niche of mid-scale supercomputers, or "Crayettes," appears to be within reach of French industry, provided the latter is prepared to undertake the outlays necessary to capture market shares.

This report, in sum, was prepared by the body known as the Caseau Commission (we note in passing that on 1 November Mr Caseau was appointed to his present position as director of EDF [French Electric [Power] Company] Studies and Research). The Caseau Commission devoted its efforts to the study of computers to determine the best course to be followed by France. (This commission succeeded the so-called LIONS Commission, which was formed in 1980 and which launched the ISIS project headed by Bull, and the Marianne Marie headed by Thomson).

The Caseau Report cites two French accomplishments: —1) a Cray-level supercomputer by Bull (ISIS project); —2) a "Crayette-type" supercomputer, somewhat lower in level of performance than the above and not quite "top of the line," but involving a "superfine" technology by Thomson Simsa Sintra.

Among its findings, the report points out the existence today of 100 to 200-person teams that are competent in the realm of parallel computers. More than 50 percent of these teams work in industry.

Given the existence of this capability, what should be done at the industrial level? —1) Industrialize ISIS? Possibly. But the field chosen with this project was that of scientific computation, a field that has long been dominated by Cray and that is now under siege by Control Data and Fujitsu, and a short-term target of IBM (which has teamed up with Supercomputer Systems Inc [SSI]). In other words, industrializing ISIS would amount to a very sizable industrial risk. —2) Industrializing Thomson's "Crayette-level" product, as we call it, appears to be a more promising strategy. It will allow a larger number of clients to be satisfied, and this niche is still reasonably open to new players: If French industry can gain a foothold in this market by 1990, for example, its chances of placing favorably in the ensuing race are real. If it waits until 1995, that will be too late.

The Commission also emphasizes the importance of developing operating softwares as well as applications softwares for which available French capabilities are insufficient. The efforts of industrial teams will have to be combined with those of university teams, and it will undoubtedly be necessary to have softwares developed in the United States.

And one last but not the least important point is that although the French capability exists, the success of French supercomputers will also depend on French industry's determination to capture market shares (hence to put forth the necessary outlays to accomplish its objectives).

Will the Government contribute its share to that operation? Yes, provided it sees a steadfast determination on the part of the industrialists to capture a position in the market.

9238

**SCS 40 Supercomputer Tested at Ecole Polytechnique in France**  
*36980183b Paris ZERO UN INFORMATIQUE in French 15 Feb 88 p 65*

[Article by Rene-Pierre Balme]

[Excerpts] "All science has been, is or will be avant-garde. Chemistry must regain the luxury it enjoyed in France not many years ago." In the view of Bernard Esambert, chairman of the board of directors of the Ecole Polytechnique, who spoke these words at the inauguration ceremony of the SCS 40 vectorial supercomputer last week on the Palaiseau premises, there can be no doubt that, cost what it may, chemistry must have adequate means at its disposal if this country is to have at its disposal a viable potential in the form of top-flight chemical researchers.

**A Scientific Computer 100-Percent Compatible With the Cray X-MP**

The Scientific Computer Systems SCS 40 vectorial calculator is fully compatible with the Cray X-MP, since it uses the same instruction set, CAL assembler, Fortran 77 automatic-vectorization type compilers, and the libraries of scientific and mathematical modules available for the Cray line.

**Chemistry To Benefit Greatly From Added Computer Power Availability**

The SCS 40 is connected to the Ethernet network of the Ecole Polytechnique laboratories, to which the CIRCE [Interregional Electronics Computer Center] and CCVR [Vector Calculus Center for Research] computers are also connected. The first users of the SCS 40 will be the chemistry and reaction-mechanisms laboratories, which, given this computer's total compatibility with the Crays (not the Cray 2, however), will be able to benefit directly from the softwares developed in this domain by the UCSD [University of California at San Diego] on an SCS 40 and a Cray X-MP/48.

Under an agreement with the X chemical laboratories, SCS, which loaned the SCS 40 to the Ecole for a period of 18 months, has reserved the right to use 40 percent of the machine's resources. These resources have been made available to French and European research teams.

9238

**DEFENSE INDUSTRIES**

**France Develops Digital Sonar for Minesweeping**  
*36980198 INDUSTRIES ET TECHNIQUES in French 2 Feb 88 pp 75-77*

[Article by Pascale Lucius: "Minesweeping"]

[Excerpts] France is one of the world's big specialists in minesweeping. A second generation of 10 ships appeared at the start of the present decade, with their advanced sonar equipment and their PAP's, the self-propelled neutralization fish—two techniques that have been resumed and improved for the third generation of minesweepers now being developed.

Nearly a routine affair in the port of Cherbourg. On the mission's agenda: sea-bottom surveillance, the location of unusual objects that have not been marked on charts of the sea bottom. "This type of activity is particularly necessary for the emergence of nuclear submarines into territorial waters," Gerard Guyodo, chief armament engineer in the Armament Ministry and a minesweeping specialist, explained. Surveillance is, of course, stepped up in the Brest area. Thus France maintains a whole specialized fleet: five Circes dating from the 1970's, 10 tripartite minesweepers built in the early 1980's and, soon, third-generation ships, the BAMO's, oceanic minesweepers, five of which will be available by about 1990.

**Acoustic Minesweeping Better Than Magnetic**

It is useful to know one's enemy well before studying ways of countering him. There are actually three types of mines currently in use: Contact mines, which drift on the surface of the sea and pose a threat to civilian ships in particular. Mines detonated with the aid of sensors. They are sensitive to the magnetism of the ships, their "noise" and variations in the pressure field caused by the forward motion of a ship. They may lie on the sea bottom, be placed between two bodies of water like the German Army buoy-rope mines or float on the surface. And lastly, the third type, mobile mines, sorts of dormant torpedoes laid on the sea bottom which are activated by the passage of a ship. "These most sophisticated devices pose the greatest of military threats," Gerardo Guyodo explained. The Americans have christened their mobile mines Captor. As for France, it does not have any. More vicious, these mines thus become more selective. Captors are today capable of choosing their target by deciphering the acoustic signature of the ship and identifying the sound of the engine or an instrument like the propellor, for example.

To counter this new generation of mines, we have had to change the techniques of dredging to disarm the explosive device and of minesweeping per se to destroy it. We are indebted to GESMA, the Atlantic Submarine Research Teams, subsidiary to the Ministry of Defense

and located in Brest, for the most significant advances in research and development. To it we in particular owe the AP4, a new French acoustic minesweeper, as yet in the prototype phase.

#### Each Minesweeper Is Equipped with Two PAP's

But diver missions are more and more often being taken over by "PAP" (for self-propelled fish)—a small submarine vehicle equipped with a jvideo camera—missions. The PAP is guided by remote control to the mine where it releases its explosive charge. Each minesweeper is equipped with two PAP's. A minor technological marvel designed by GESMA and developed by ECA (Meudon), a company that specializes in submarine systems and works in close collaboration with IFREMER. The first PAP, which goes back to the 1970's, was developed in collaboration with GESMA. Since then, "PAP technology, linked with electronics technology, has evolved considerably," Mr Lauvray, the merchandising manager of ECA, which has a sales volume of 170 million francs, explained. "We have perfected a unique device, one that is not very magnetic, makes little noise and is inexpensive." From 1.5 to 2 million francs, all the same. But today about 60 PAP's are in operation in France. So, the British Navy has also adopted it, as well as many other countries, like Belgium, the FRG and the Netherlands.

Sonar and PAP are the technologies that have proven themselves and which will, of course, be found aboard the BAMO, the celebrated oceanic minesweeper the construction of which is provided for in the spring 1987 military law. But the BAMO will not be quite like its equals. First of all, sonar technology has evolved. The Circe generation was equipped with DUBM 20 sonars, the tripartite minesweeper sonars and DUBM 21B sonars. As for the BAMO's, they will have DUBM 42 sonars in tow behind them. "This digital—not analog—sonar performs much better," they explained at Thomson in Brest. "It will no longer be an onboard sonar. It will be towed behind the ship and have a peripheral vision of 200 meters, whereas the old sonars were limited to 50 meters. The DUBM 42 will permit the ship to sail faster, up to 10 knots instead of 4." The prototype, which will be ready in late 1989, will be the first of its kind. The English are already lining up to buy a few samples!

On board, the instruments will be more sophisticated, as, for example, the Syledis, a radiolocation system built by the Cercel Company. And lastly, even the design of the ship is new. To be built in Lorient by the Department of Shipbuilding and Armament, the vessel will be a catamaran, an entirely new naval solution that will make it possible to obtain greater stability. The hull of the vessel will be made of composite material, glass and resin. For a cost roughly equivalent to the cost of steel, this material will eliminate maintenance and corrosion problems. The studies on the resistance of the material when used on this scale—the BAMO will weigh 900 tons—were conducted by GESMA. Five BAMO's are planned, each of them costing about 300 million francs. Five

others are to follow. This program is expected to result in a considerable number of civilian applications, particularly in offshore hydrography.

Captions p 76 [figures not reproduced]

#### Typical Procedure in a PAP Operation

1. Detection of a potential mine by ship sonar.
2. Steering the PAP 104 by wire guide.
3. Identification of the mine through TV or sonar and placement of the explosive charge.
4. Recovery of the PAP. Destruction of the mine by remote detonation.

11466

#### Augusta/Westland's EH 101 Makes Maiden Flight

36980194d Milan *TELEMATICA* 2000 in Italian  
14 Oct 87 p 2

[Text] London, 14 October 1987. The EH 101, the largest helicopter built to date by the Augusta Group and by the English Westland Company, made its maiden flight after having completed a program of tests on land. The PP1, as the first pre-production aircraft was called, will begin the most intensive flight test program ever carried out, at least to date, by any helicopter. The program provides that the nine pre-production prototypes fly for 5,000 hours overall, both in Italy and in Great Britain.

The EH 101 has a good commercial outlook, with sales forecast to be at least 800 billion. The British and Italian navies have ordered 50 and 42 of the helicopters, respectively. Another order has been placed by the British Defense Ministry for the procurement of 25 EH 101's, in the utility version, while the Italian Army and Air Force have expressed their interest for these heavy helicopters. Canada is on its way to becoming the first customer with an order of 50 EH 101's intended to replace the helicopters currently used for defense of the country and the supply will have an overall value of more than 2,000 billion lire. (T.2000)

13331

#### LASERS, SENSORS, OPTICS

##### Prospects, Applications of Innovative Electroluminescence Materials Systems Examined

3698m251 Milan *INDUSTRIA OGGI* in Italian  
No 13, Jan-Feb 88 pp 60-64

[INDUSTRIA OGGI interview with Elio A. Savi, managing director of Sinel S.p.A., leading Italian manufacturer of electroluminescent materials and devices: "New Electroluminescent Systems for 21st-Century Europe," first eight paragraphs INDUSTRIA OGGI introduction]

[Text] Lucanya, the new electroluminescent system that Sinel, a company of the ENICHEM Group, is now launching on the Italian and European markets, is thin

and flexible, may be bent, and is clearly visible even from long distances. The aim of the whole marketing operation is the dissemination of knowledge on electroluminescent materials and the shift from uses limited to very specific technological sectors to mass production.

To achieve these objectives, such prestigious companies as Loctite, a sophisticated U.S. multinational operating in the sector of fine chemicals, Sumitono (the largest Japanese chemical group), and Enichem grouped themselves into a cooperative pool operating at world level, setting up a joint research venture and acquiring the licenses for technology developed by Luminescent System.

These systems, which originally were intended primarily for backlighting, open up new prospects for the evolution of electronic components, automobiles, interior decoration, and household appliances because they are compact, and relatively small and, with a single homogeneous system, are able to provide fully recognizable information even from difficult positions and offer innovative solutions for the most diverse markets.

#### From Avionics to Design

Electroluminescent devices have a multilayer structure that includes the luminescent material; the entire system can be compared to a parallel plates capacitor.

The structure, manufactured using a complex technological cycle, is then protected with a highly transparent and waterproof polymer film packaging.

What prospects does the regular use of these materials open up in the various sectors? What are the major advantages offered by such a product in relation to existing solutions?

The above questions were posed to Mr Elio A. Savi, managing director of Sinel S.p.A.

**INDUSTRIA OGGI:** Which sectors are most interested in such products and what is their market potential?

**Elio A. Savi:** At present the product is used primarily in avionics and instrumentation (CD backlighting), but in the United States, and to an ever greater extent in Japan too, it is also partially employed in the automobile sector. For our part, we aim to launch electroluminescent material on the European market with a twin objective: to increase awareness of this product and its use in nontraditional sectors such as that of widely used components, household appliances, and automobiles, as well as interior decoration and design; our aim is to show technical experts and the general public the specific characteristics of this material, as well as its versatility and reliability. In this way, it will be possible to achieve mass production of a product that is currently used in very specific sectors only.

When talking about potential, one must remember that it is only recently that markets have begun to be approached with targeted strategies. Indeed, ENI [National Hydrocarbons Organization] is the only large European company committed to the development of such a program, especially with reference to instrumentation and liquid crystal backlighting, where this material could be of interest because electroluminescent backlighting is a valid support to meet legibility requirements independently of light conditions. This characteristic is essential to enter certain mass markets. Italy is not the only country involved in this industrial operation; international cooperation is necessary if certain goals are to be reached. Our agreement with Luminescent System, Loctite, and Sumitomo Chemical Company enabled us to set up a joint research venture aimed at avoiding competition among the companies involved and at creating a relationship of cooperation that will enable us to promote the same product on three different markets: Europe, the United States, and Japan. Obviously, each market has its own characteristics and problems, but this common effort aims at giving credibility to a new product that can rely on a prestigious alliance.

Sinel also intends to launch "components" based on the use of electroluminescence. They include the recently developed backlit liquid crystal for mechanical keyboards with electro-optical controls, or for membrane keyboards (where electronic components make it possible to display both the light and the key involved in the function; these also include large electroluminescent displays, a comparatively cheap solution to the problems posed by the display of data or of fixed or variable functions. In this way, technicians can exploit a substantially uniform technology for different problems. For example, in safety or emergency communications we are accustomed to using standards, symbols, or codes that are basically uniform and universally recognizable, but the variable communication characteristic of electronic technology does not comply with this rule. Electroluminescence represents a solution that makes it possible to use the same graphic sign with both moving or fixed communications, both with or without light. These are safety factors in that they facilitate immediate recognition.

**INDUSTRIA OGGI:** Is Sinel involved in marketing only, or will it expand its research and development activities as well?

**Elio A. Savi:** Sinel is not concerned only with marketing. At the moment, in fact, it is concerned primarily with research and development and the production of these devices. We are now organizing our marketing activity along two lines: on the one hand we are seeking reference points for distributing the product in all European countries, while on the other hand we intend to establish preferential relationships with partners who are leaders in their own sectors for the development of specific applications. In this way the product will be presented on the various market sectors thanks to the intervention of

qualified companies, thus making it possible for us to adapt it to meet market requirements. For this reason, cooperation is under way with companies such as Philips, Elettrocondutture, and Saporiti Italia.

#### A New Material For A New Market

**INDUSTRIA OGGI:** What are the principal characteristics of this material?

**Elio A. Savi:** It is flexible, non-flammable, and strong; it emits cold light and is therefore suitable for use with other materials. Light emission is specific, which means that it is visible from long distances and from the side. It is not a punctiform light surface, and therefore guarantees excellent visibility even though it is not bright. It is a new optoelectronic material in that it permits surface display of information transmitted with electric signals and supports information through the surface, as with liquid crystals. It is a system incorporating various functions, several lights, and a number of wiring systems. Therefore, extremely compact components (1.5 mm thick) that have greater flexibility and are easy to use, can be manufactured. While we essentially aim to introduce the product, we also intend to modify it according to the requirements—including price requirements—of the various sectors. Our research is directed toward optimizing the structure of the device according to the characteristics of the application sectors. Hence, research and development at world level on production technologies for the device and primary luminescence structure (that is, phosphorus) is essential for the future of this product. Furthermore, these products offer a large company such as ENI an opportunity to enter a new market, that of electronic components, and to embark on stimulating research plans.

**INDUSTRIA OGGI:** Does this mean that you are creating a new market?

**Elio A. Savi:** We are creating a totally new market for this product which, however, will be modified according to the requirements of the various sectors where it will be proposed. For instance, the automobile industry requires comparatively low prices and large-scale production, while lighting design and avionics have different needs.

The Lucanya material is valid in all these fields, but it obviously needs to be targeted to each specific one. For example, the backlighting of flat-screen displays, which will be an extremely interesting product in the electronic components market over the next few years, will require brighter materials at lower costs. The solution in this case is represented by a mass technology to replace the existing one while hard-wearing products will be necessary for the automobile sector. Therefore, large investments will be needed for research and development because only a large company can meet a challenge aimed at the creation of a stable and highly competitive market.

**INDUSTRIA OGGI:** What are the present and future applications?

**Elio A. Savi:** At present, electroluminescent materials are used primarily in avionics as aircraft external recognition lights or for the backlighting of internal instrument panels. They are also used in instrumentation for the backlighting of liquid crystals or for long-distance recognition of symbols and signals. Thanks to their excellent visibility, they are also used in the automobile industry, in shipbuilding, and for military applications.

New applications include the sector of household appliances, which is now being studied with great interest. Today we are accustomed to using mechanical keyboards with unlit cryptograms which generally do not allow connection of the key pressed to the function actually performed by the machine. The luminescent panel, on the other hand, ensures that the function of the mechanical button (essential in a household appliance because of the power involved) is accompanied by information by making visible both the button and the function involved. Indeed, thanks to the electroluminescent material, the signal, picture, graphics, and functions involved are all clearly visible. In short, the trend in household appliances is to replace the outdated concept of light bulbs (which, though more economical, provide an ON/OFF answer only) with an electroluminescent information system capable of producing an image—typical of a monitor—that is fully compatible with the electronic evolution of these household machines.

However, extremely diverse sectors are touched on by this approach toward new applications. In the spring we will launch a production line for information and safety, and at the same time we are devising solutions for remote information with active electroluminescent displays; these could have extremely interesting applications not only for information on roads at national level, particularly at nighttime or for information in airports, but also for information in schools.

Part of our work at Sinel is aimed at identifying ways to use these systems to simplify data processing through use of this kind of display (large screens). Cromakeys, special devices used in television studios, are another new field. They provide cameramen with a color component that poses no interference problems and ensures a clear contrast between actors and background. We are also developing special safety signals to ensure the recognition of the wavelengths concerned, shapes, and the friend/foe function.

Future plans aim at extending the use of these products not only in the technology sector but also in design, through color, surface, etc. We also intend to promote these systems as components to be used by Enichem, through Sinel, to develop other optoelectronic components, particularly flat-screen displays, where electroluminescence constitutes a solution to the problem of replacing the cumbersome cathode ray tube. This policy

would open up the markets of portable personal computers, instrumentation, applications on military vehicles, or monitors located in very sensitive places. The company's commitment to a research program along these lines gives a special significance to our work, that is, the creation of operational structures, expertise, and awareness at ENI so that an even more advanced technological level can be achieved in this material.

#### Technology and Investment

**INDUSTRIA OGGI:** What kind of manufacturing technology have you adopted?

**Elio A. Savi:** Manufacturing technology is directly related to the evolution of this product over the past decade and to the specific nature of the materials employed. Although the product has the appearance of a strong plastic film it in fact is a multilayer structure and has a minimum of nine and a maximum of 12-13 components requiring a special anti-humidity processing cycle to protect the material over time. In this respect, this technology is essentially geared to a limited number of applications. Investments are now being made, and these will be completed in the second half of 1988; these aim to develop a more integrated technology through product-related automation. Our objective is to establish market relations that will mean that by late 1988 or early 1989 demand for the product will be sufficient to justify introduction of the integrated cycle now under development. Therefore, future production technologies will be diversified according to the different materials used to manufacture the electroluminescent devices developed for the various market sectors. With a few possible simplifications relating to changes in the materials or replacement of the materials, the technology currently used will remain the most suitable for the development of applications in avionics or interior decoration, where limited numbers of units are required. Great importance will be attached to design, graphics, and studies carried out upon customer request, while automated and integrated production will gradually be developed for products to be sold in the automobile, household appliances, instrumentation, and communication sectors. For this reason, the very nature of the materials employed—some of which we are now seeking to replace—will influence the technology and product-related results.

This means, for example, that in the backlighting of a liquid-crystal flat screen, where the brightness and life of the device are of great importance, excellent performance levels will have to be achieved, on the other hand, in fields where these features are less important, and for applications requiring highly competitive prices, a more economical technology can be developed. Our action on the various market segments should provide us with very useful information in this connection.

We are also re-examining the possible uses of a material that is now employed primarily in backlighting or displays, with a view to using it as an information system also.

We are already in a position to exploit the segmented nature of the device to make a system capable of being used in different ways, and able to support either different messages or compatible messages through the composition of these surfaces (multifunction display logic). This is the intermediate stage that will enable us to produce flat-screen, high-definition displays that are competitive with video terminals.

**INDUSTRIA OGGI:** What are the costs and the availability of the product?

**Elio A. Savi:** At present these devices have to be compared to traditional ones (both lighting equipment and components and electronics). In certain applications it is still an expensive material in comparison with more widely known solutions; however, we aim to achieve a dramatic cut in prices in 1988. There are also situations in which electroluminescent systems afford overall structural savings, and this leads us to be optimistic concerning the competitive potential of electroluminescent materials compared with traditional solutions.

The Lucanya material has been available on the market since June 1987 and is produced at our Pisticci plant, near Matera. I would like to point out that this reconversion operation has led to the production of a technologically advanced material in the production of Italy, and this has had positive repercussions on the quality of personnel, including young employees, and has also shown that a large company is able to create new initiatives in terms of technology and skilled jobs.

**INDUSTRIA OGGI:** Can electroluminescent systems be considered safe from the production viewpoint also?

**Elio A. Savi:** It is a safe product in many respects. It consumes only 0.25 mAmpere per sq.cm., which is very little indeed; and given that safety in the use of an electric or electronic component is closely related to the amount of electricity involved, this product can definitely be considered safe. Its high reliability is further shown by the fact that its sheath, which belongs to the teflon family has high insulating properties; also, it is non-flammable, can be trodden on, and emits cold light. If cut, it goes on working in the part still connected to the cable, and the minimum amount of current that goes through the cut gives no shock. If pierced, the system activity is not interrupted, but continues with a minimum voltage.

The product is manufactured in white rooms in conditions of great cleanliness so as not to affect the transparency of the material; there are no large amounts of liquid effluent (with the exception of phosphorus production the basic raw material that we buy); it presents certain



problems in terms of vapor, but this is kept under control by the fact that the work is done in properly conditioned rooms. It is a safe technology because it does not require large machines; the adoption of automated machines for the control function also has already been planned.

**INDUSTRIA OGGI:** What kind of assistance will users receive?

**Elio A. Savi:** A laboratory has been set up in Milan to support market action in terms of both promotion and service for prototypes, tests, and verification of the characteristics of the material. With the companies collaborating with us, we seek to reach agreements both at the technical level and in terms of product development. The distributors who are being prepared for Europe should also guarantee an adequate level of information. For the time being, technical assistance is based in Milan only. However, future developments will lead to the establishment of similar structures in other countries to address the problems of the various sectors in the different markets in a timely manner.

**INDUSTRIA OGGI:** How did Italian operators react?

**Elio A. Savi:** I personally have found more favorable reactions in Sweden, France, and the FRG, but I believe that the reason for this lies with the nature of the Italian electronics market. In Italy, however, stable foundations are being laid for developments in new sectors such as household appliances, automobiles (we are developing a new line of safety-oriented car options to be produced in collaboration with Rold), as well as communications and other applications (in cooperation with Elettroncondutture), and interior decoration (with Saporiti Italia). Electroluminescent systems are aimed not only at replacing, but also at integrating existing traditional systems. In the automobiles sector we are establishing contacts with companies operating in the electronic components sector. We are also starting to cooperate with companies that will be using electroluminescence for large liquid crystal backlighting systems in connection with flat screens for portable personal computers. In 1988 these lines of action will give us a clearer picture of this "mass" market, and this will also stimulate investments.

08708

#### **BMFT Subsidizes Optical Laser Components Development**

3698m210 Bonn *TECHNOLOGIE*  
*NACHRICHTEN-MANAGEMENT INFORMATION*  
in German No 471, 15 Jan 88 pp 5-6

[Text of BMFT announcement regarding the subsidy of projects within the framework of the priority research "Laser Research and Laser Technology," issued 23 December 1987 in Bonn]

[Text] 1. The subsidy priority "Laser Research and Laser Technology" by the Federal Ministry of Research and Technology (BMFT) entails the subsidy of research projects for the solution of overall industrial, future oriented problems in the area of optical laser components.

Subsidies are available for research work characterized by high risk, particular complexity, and high general expenses thus requiring multidisciplinary efforts. These problems must be solved through joint cooperation of companies and research institutions.

2. The objectives of these research projects must be optical laser components which meet the requirements for laser sources and laser systems in industrial manufacturing and production engineering, test methods, analysis, and medical engineering. The characteristics of CO<sub>2</sub> lasers, solid state lasers, excimer lasers, and rare gas lasers make them particularly suitable for these application areas.

The primary focus of the research work should be on the following specific areas of the thematic research:

- manufacture and preparation of solid material optics and substrates,
- coating of optical elements for specified reflection and transmission characteristics, protection against wear, and sealing,
- manufacture and testing of elements with special features (for example modulators, adaptive optics, polarizers),
- test methods for laser-specific optics, and
- research in the area of optical fibers for the transmission of energy.

Research work on laser components whose achievements are not expected to be exploited for a wide range of applications at an industrial level will not be subsidized. Any proposals for projects which do not go beyond the present state of the art also will not be considered.

3. Companies and research institutions are invited to cooperate actively and informally.

Overall, industrial joint research projects will be subsidized. Proposals for those projects in which concrete cooperation plans between companies and research institutions (for example, the Fraunhofer Society, the Max Planck Society, universities) already exist in comparable specific areas of the thematic research will be especially taken into account.

4. The BMFT will subsidize joint projects depending on available budget funds. Subsidy measures for industrial companies require at least 50 percent participation of the firms involved. As a rule, industry's share in the expenses of institutions must amount to 25 percent. Industrial participation may also be rendered in the form of valuable services (for example by making special operational facilities or materials available).

The BMFT management rules which are in force at a given time are applicable. A legal entitlement to subsidy does not exist. Subsidy decisions will take into account

ongoing subsidy measures and research projects planned for other areas of research (for example, EUREKA projects) in order to avoid inefficient, duplicate subsidies.

5. Proposals for the aforementioned research projects, which initially should be presented only as a short description of the project (especially the subject of a specific project, its objective, the work and time schedules, requested funds, participating partners), must be sent to the following project management before 21 March 1988: VDI technology center -physical technologies- Graf Recke Strasse 84 4000 Duesseldorf 1

6. Further information and documentation for subsidies in the area of optical laser components is available at the project management in the VDI technology center.

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Bonn, 23 December 1987

[Signed] The federal minister for research and technology

On behalf: Dr Roehrig

08617

## MICROELECTRONICS

### BMFT Plans Subsidies for Ion, Plasma Technology Projects

3698m207 Duesseldorf VDI NACHRICHTEN in German No 2, 15 Jan 88 p 2

[Article by Siegfried Kaempfer: "Ion and Plasma Technology Promoted as Key Technologies; Thin Films Highly Recommended; Low Process Temperatures Enliven Surface Technology"]

[Excerpts] Duesseldorf, 15 January 1988 (VDI-N)—Ion and plasma surface technology is growing even faster than microelectronics. According to Professor K. T. Rie of the Braunschweig technical university, although research and development enjoy a high position in the FRG there is a danger of falling behind in the relative plasma and ion beam supported processes.

Rie stated, "in addition to form and stability, surface characteristics are especially important for technical products." And that is the case despite the fact that they only account for between 5 and 15 percent of the total value.

Reflecting layers on window glass, for example, have a current worldwide production value of DM1.5 billion; in fact, they make up a 10 million square meter total surface, produced in a vacuum by cathode pulverization. This "sputtering" is also used for watch casings and bracelets: here, the potential in the FRG is some 3.6

million pieces per year. According to an investigation by the VDI technology center (VDI-TZ) in Duesseldorf, this is equivalent to a coating value of about DM 60 million; while in Japan, greater use makes it possible to assume an annual surface production to the value of about DM 300 million.

Another example: a good one-half of drills and one-third of gear cutting and broaching tools in the FRG are ion plated, that is, they have a golden film titanium nitride (TiN), which reduces wear and tear. If we assume a 20 percent added value for the coating, this represents a value of about DM 350 million per year. Similar figures are also applicable in the United States and Europe, according to the VDI technology center.

Growth everywhere: it is hardly surprising that various branch spokesmen have joined together in a joint "plasma surface technology" committee.

The current volume of world thin film technology production is estimated by the VDI technology center to be worth around DM6.5 billion. Of this, Japanese producers account for about one-quarter, while FRG producers account for only 5 percent. In addition, the FRG market, for example in ion supported processes, reaches only about 5 percent of the world market. "This shows a clear underdevelopment," according to the VDI technology center. Thus Leybold AG, for example has about 40 percent of its thin film technology business in the United States alone.

A study by the VDI technology center also established that growth rates in the market for vacuum facilities for thin film production in Japan has been between 20 to 25 percent since 1980. About 37 percent of all vacuum equipment there is used in the microelectronics industry; about 18 percent is used in producing films for other sectors. The remainder consists of components, metallurgical equipment, clean room technology, and so on.

The race to catch up has begun. By the end of last year, the working group on plasma surface technology that was established in 1983 was already in a position to discuss the final report of a BMFT [FRG Ministry for Research and Technology] preparatory project. On this basis, the VDI technology center, as a BMFT project contractor, presented requests for a subsidy program.

One point is already certain, the German Research Society (DFG) has approved a priority program on "Ion and Plasma Surface Technology," aimed primarily at low process temperatures below 500 degrees C since one of the advantages of this process is that the substrate is not altered by higher temperatures. According to DFG spokesman Professor H.G. Dohmen, applications in machinery and instrument construction, applications in the field of metal-cutting processes, and in cold, lukewarm, and remodelling technology will be funded; purely decorative applications are excluded.

08702

**Italian Engineers Develop 'Air Bridge Gate FET'**  
36980190c Milan *ELETTRONICA OGGI* in Italian  
Jan 88 p 14

[Brief: "Innovazione Elettronica 1987' Prize Awarded"]

[Text] "Innovazione Elettronica 1987," the prize instituted by Selenia, has been awarded to Giampiero Donzelli, of Telettra, and to Ezio Maria Bastida, of CISE, for their research on and development of a MESFET transistor with a layer of air between the gate electrode connections to the carrier (Air Bridge Gate FET). The statement of reasons for the award pointed out that the new MESFET transistor structure, designed by the two finalists, results in a substantial reduction of the gate electrode resistance, through the use of an electrode in the form of a continuous film that overpasses a portion of source contact, creating a layer of air between the two connections. The reduction of resistance is fundamental in uses at extremely high frequencies, from the standpoints both of low-noise amplifiers and power.

The project was developed under the Components and Technologies Division at Telettra, where Donzelli heads research and development work on gallium arsenide circuits and devices.

9238

## NUCLEAR ENGINEERING

**French Laue Langevin Institute Discovers New Isotopes**  
3698m233 Bonn *TECHNOLOGIE*  
*NACHRICHTEN-MANAGEMENT*  
*INFORMATIONEN* in German No 472, 29 Jan 88 p 11

[Text] A dozen new and so far unknown isotopes of nickel and copper have been discovered at the Laue-Langevin Institute in Grenoble, France. Thermal neutrons were used to detect these extremely rare fission products of uranium-235. Although the detection of these rare and short-lived atomic cores is in itself a major success, the discovery of nickel isotopes with mass numbers 70 and 76 is particularly important since it sets a milestone toward the detection of isotope nickel-78. The analysis of the physical properties of its atomic core will then measure on the one hand the accuracy of present theories on the inner structure of atomic cores and on the other it will allow to understand their formation within the framework of cosmic particle synthesis.

Extremely accurate and sensitive detection of fragments resulting from the fission of uranium, also known as fission products, is one of the ILL's specialities. In 1967, the Institute was founded as a France-German initiative; Britain joined in 1973, Spain in 1987, and Switzerland in 1988. The FRG is represented within the Institute by

the Karlsruhe-based Nuclear Research Center; one-third of its DM80 million annual budget is provided by the Federal Ministry for Research and Technology. The ILL is a world leader in structural research with neutrons and analysis of the fundamental properties of neutrons with its very high-flux reactor. Each year 1,700 guest researchers, mainly from the five member countries, carry out research there.

08802

## SCIENCE & TECHNOLOGY POLICY

**Italian Policymakers Meet to Discuss S&T Issues**  
36980194a Rome *NOTIZIE AIRI* in Italian  
Oct 87 pp 13-20

[Text] The report on the status of scientific and technological research in Italy in 1987 was presented by the head of the National Research Center (CNR), Luigi Rossi Bernardi, on the occasion of the "CNR Science and Technology Conference," where world famous representatives of Italian research met for three days in Rome (October 6-8) to discuss today's problems in this sector.

The CNR report shows that Italian research (both public and private) expects to spend in 1987 a total of 13,669 billion lire, an increase of 22.3 percent (about 17 percent in real terms) over the 11,175 billion spent last year. The percentage of gross national product of this expenditure (the most meaningful comparison, since it is comparable to the percentage of other countries), however, is expected to be 1.4 percent, which is less than the 1.46 percent of 1986. The large industrialized countries have percentages of 2.2 and 2.8; the average amount for EEC countries is 1.9 percent. Included in the total figure for 1987 research is the sum of 6,337 billion for Government administration, the research agencies, other public entities, and the university; the remaining 7,332 billion come from public and private enterprises and from the National Electrical Energy Agency (ENEL). The respective percentages are 46.4 percent for public administration (in 1986 it was 48.9 percent) and 53.6 percent for businesses.

The report emphasizes that distribution of public outlays for educational sectors continues to favor research in engineering and technology (18 percent), followed by biological and medical sciences (14.4 percent, with an increase of 48.5 percent compared to 1986), physical sciences (11.9 percent) and space research (11.4 percent). The report emphasizes that "outlays for nuclear research (7 percent of the total compared to 12.5 percent in 1986) are clearly declining due to the decreased funds granted to the European Nuclear Energy Agency (ENEA), which registered a drop in allocations of 18 percent, confirming a wait-and-see posture with regard to the government choices in energy policy."

Specifically, the report underscores the fact that the research budget of the Ministry of Public Education (which represents 34.5 percent of the public sector) increased by 28.5 percent and the CNR budget increased by 35.8 percent. Furthermore, the CNR had an increase of 19.2 percent of the funds for ordinary funding and a doubling of funds intended for the national space program (400 billion); with an endowment of 1,200 billion lire for 1987, the CNR disposes of about a fifth of the appropriations for the public sector. Added to this figure are 105 billion for the 10 newly completed projects, the proposals for the extraordinary intervention in the South, the accords with other agencies or entities, and those requested at the FIO.

Concerning the drop in public funding, the report also underscores the smaller outlays for research by the Ministry of Defense (down 8.8 percent). On the other hand, there are increases by the Ministry of Agriculture (up 30.11 percent), the Ministry of Health, and the Ministry of Culture, the National Institute of Nuclear Physics, and the Health Institute. With regard to the distribution by type of research, the report emphasizes that "pure" research is 90 percent financed by public agencies.

The minister for research, Antonio Ruberti, speaking at the presentation of the report, stated that "it is now time for Italian research to be organized under a multi-year plan that would establish priority objectives and remove obstacles such as the lack of mobility of researchers and the shortage of shared facilities; what is most lacking, however, is a ministry that governs the entire sector with a single voice."

The future university and research ministry, for which draft legislation is currently being studied in the Senate, was the main topic of the press conference that followed the report.

The draft legislation, according to Rossi Bernardi, has been examined by the CNR Consulting Committees, which, "even without the heated criticism directed against almost all the previous plans to reform the sector, have asked for more precision in defining the roles of the research sphere and the political sphere." Researchers "should be recognized as having the tasks of directing the research, while politicians direct the modes and implementation times." Ruberti and Rossi Bernardi found themselves agreeing about the need for the new law to protect the special role and independence of the CNR in its research coordination functions.

Among the most immediate initiatives for improving the coordination of research agencies, Ruberti emphasized that the 1988 financial law provides for establishment of a special fund. Then, concerning the training of researchers, Ruberti proposed that any initiative (completed projects, future space agency, interventions in the South) set aside 10 percent of its funds for this purpose.

Besides the training of new researchers, Rossi Bernardi also stated that favorable conditions should be created for the return of those who are working abroad. For example, many Italian researchers are working at the American medical research center at Bethesda, one of the best in the world, and the Italian group is the largest in number there, except for the Japanese.

Rossi Bernardi, in conclusion, recalled that the CNR's Mezzogiorno development plan foresees 31 new institutes and research centers, the training of over 3,000 young people, and hiring of 1,621 researchers and technicians, construction of eight integrated research areas, and execution of nine strategic projects, for a total outlay of 740 billion over the period from 1987 to 1990.

Also participating in the CNR conference was, among others, the Director of the National Space Program, Professor Guerriero, who stated that, "while awaiting the approval of the National Space Agency, we must do something to allow the National Research Council to better manage the national space program, which in 1980 was "temporarily, for 6 months" entrusted to it. To manage the plan, the CNR had to create a full-time staff and the approval of a project necessarily requires much time for inspection by eight separate agencies, from the Consulting Committees to the President."

Cooperation for space research among public research entities and state-owned enterprises has been proposed by Luigi Granelli, minister of state-owned enterprise. Granelli, who for four years was the minister of research and the first to present the legislative language on space research, proposed a research network shared by the universities, the CNR, and state-owned groups because "the 2,581 billion that the latter invested in research are insufficient to develop investment levels appropriate for the space sector."

Among the problems of the space program, Guerriero cited those of the technicians, hired under non-renewable five-year contracts while awaiting judicial recognition of the space program or of a national agency.

Guerriero emphasized that among the most urgent problems for the space program is the assignment to the CNR of full responsibility for relations with international entities as well.

At present, the Space Office of the Ministry of Research manages the relations with NASA and the ESA. With respect to the problem of technical personnel (over 70 percent have time-limited contracts), Guerriero confirmed the need to provide assurances to the staff and prevent them from turning toward industry or other research entities. As to the possibility of cooperation with China, mentioned as a possibility on the occasion of accords such as the agreement for "Sirio" or during reciprocal visits of technical delegations, Guerriero stated that to date the Chinese "have only attempted to

obtain technology, without a true exchange; however, it would be advantageous to be able to exchange our knowledge of satellites with their launch capability."

A special round table was devoted to the problems of "Scientific Research and Industry."

Chaired by L. De Rosa and G. Modena, the round table included: L. Dadda, R. Ugo, C.E. Rossi, R. Passino, R. Roveda, A. Airaghi, F. alla Valle, A. Ovi, P. Bisogno, and A. Ruberti.

The round table's starting point was the draft legislation relating to the establishment of the new Ministry of the University and research, which was put forward recently.

Professor Dadda underscored the need to consider research activities as support and sustenance for the development of the country, rather than as merely self-generating activities.

This consideration, which reflects a change in the current thinking of people active in the sector (both public and private, industrial and non-industrial), should have a bearing on the design of the legislation before the government.

Professor Ugo's remarks concentrated on the training aspects. If we imagine that we are designing a new ministry as a sort of holding company for research activities—with the need to take advantage of financial, technological, and human resources—we must accent the human resources. The problems of recruiting university-trained staff and the problems relating to the inclusion of Pd.D.'s coming from abroad constitute, indeed, a serious warning sign in this sector.

Engineer C.E. Rossi emphasized the need to facilitate the process of internationalization of access to advanced technologies, pointing to the benefits of the Esprit and Eureka projects in this regard. These projects have also produced beneficial contacts, which are becoming gradually closer, between the industrial sphere and the world of research.

A new quality of design inherent in the models for regulating and managing research activities was put forward by Professor Passino, who spoke about how, in the recent past, academic research has carried out its role as purchaser, broker, and superintendent. For this purpose, the initiative of the Research Consortia that was launched by the IRI should be watched with interest.

The effects of the scientific system on the country as a whole should be studied using new indices rather than the traditional ones (aggregate data concerning the outlays for research and development as a percentage of the gross domestic product). Professor Roveda, who made this assertion, said we should identify as new indicators

the capacity to disseminate innovative technologies, increase in the use of accumulated resources, and the degree of penetration of research findings into the economic and social tissue.

We then need to emphasize the ways of organizing research so as to facilitate the mobility-dissemination of the researchers, as occurs, for example, in the university and industrial sphere in the United States.

Engineer Airaghi, noting the need to develop cooperative efforts by public and private researchers, and underscoring the validity of the IRI initiative in this regard (Research Consortia), recommended introducing tax incentives for firms that invest part of their own funds in research.

The problems of an industrial sphere in which research becomes a means of production were expressed by Engineer Dalla Valle. Whereas we have outlays for research and development of around 2 or 3 percent for other spheres, in the pharmaceutical sector, this figure jumps to 20 percent.

Engineer Olvi showed himself entirely in favor of the plan to reorganize government agencies, emphasizing the way in which this innovative activity encounters obstacles especially on the part of the researchers who are interested in innovation. The Research Consortia that are being promoted by the IRI, encouraged by the government initiative, want to aim toward a "shakeup" of the researchers and agencies and "propagation" of innovative processes.

The importance of the structures for research and innovation was discussed by Professor Bisogno, both for the purpose of reviewing certain mechanisms for allocation of funds (with the introduction of appropriate controls for the correct use of financing for innovation), as well as for the purpose of new projects (science parks).

Professor Ruberti, the minister of scientific and technological research, looking forward to the CNR's being able to constitute a central point for policy formulation of the aspects inherent in the country's research activities, said that he was shocked by the fears created by the innovations present in the above-mentioned draft legislation. The research system is changing at an ever-increasing rate, making it necessary to regulate interactions among the systems. Overcoming the problem of whether to proceed in the direction foreseen by the government's agreements, we must reflect upon how to act to improve these guidelines. The academic agencies should be reorganized to concentrate on goals (research and training) while protecting their autonomy. We need to keep our knowledge at a high level in order to avoid cultural backwardness.

The minister plans to provide the guidelines needed to implement these policies; a related matter is the recent introduction of a reserve of 10 percent of the outlays

intended for training and 10 percent for environmental protection as part of the funds allocated by the government for research activities—a contribution of 10 percent was already earmarked for the Eureka project.

13331

**Belgium: Overview of Recent S&T Policies**  
36980194c Rome NOTIZIE AIRI in Italian  
Oct 87 pp 34-38

[From documentation sent from the Italian Embassy in Brussels]

[Text] Belgium—considered to be an intermediate economic power within the sphere of the OECD, together with Spain, Australia, the Netherlands, Sweden, Switzerland, and Austria—devotes to R&D activities about 1.3 percent of gross domestic product, a level that has remained practically unchanged from 1969 to the present, placing it in an intermediate position with respect to the 2.5 percent of Sweden and the 0.5 percent of Spain.

Those working in the research sector amount to about 2.5 percent of the overall work force—approximately the same percentage as in Italy. It should be emphasized that during the general downward trend in the number of jobs, those working in research have increased 30 percent over the last five years.

State intervention on behalf of R&D has fallen off drastically in recent years, going from almost 4 percent of the total for government outlays at the beginning of the 1970s to less than 2 percent 10 years later.

With regard to the other EEC countries, Belgium spends a relatively high amount for the health sector, public healthcare, and social protection, whereas it is in a medium position with respect to research relating to economic development, basic research, defense, and space. Over 90 percent of the research conducted in the industry is self-financed, a percentage that is among the higher ones within the OECD, second only to Switzerland and Japan. In Belgium, as in Austria, Switzerland, Denmark, the Netherlands, and Japan, nine-tenths of public R&D funds go chiefly to finance university activities.

A particularly interesting item of information concerns outlays of the industrial activities for research and development; this figure has gone from 0.8 percent of added value in 1969 to the current 1.6 percent, reaching the same level as in the Netherlands.

The current Belgian government's research policy is organized around the following principles:

**1) Support to Basic Research.**

The principal guideline for action in this area is to prevent fragmentation and waste in the efforts and resources for research in order to aim instead toward establishment of research centers that are furnished with a "critical mass" adequate to produce good results.

The endowments of the National Scientific Research Fund (FNRS) and associated funds will be increased; the currently allocated appropriations for applied research will be transferred to the universities; and the Interuniversity Associations for Advanced Technologies (PAIT) will be established. Mobility of researchers will be facilitated by completion of the "researchers statute."

**2) Industry-University Collaboration.**

The goal is to encourage extension of science parks. The proposals mentioned above (the researcher statute and the interuniversity associations) should play a positive role in this policy. The government, moreover, will facilitate the approval of patents and marketing of the findings of university research.

**3) Private Financing.**

The possibilities for tax deductions for firms that hire researchers or that make investments in research activities will be increased and the use of venture capital will be facilitated.

**4) Improved Efficiency of Government Aid.**

There will be a specific effort to prevent waste and overlapping in the use of public appropriations for research. The research and technological development programs in the small and medium business sector will be particularly encouraged. An advisory board will be set up comprised of high-level experts; its task will be to direct the government's choices in the area of R&D.

Finally, some research programs will be considered to have priority over others and they will be particularly encouraged. These will be the programs for space research, artificial intelligence programs, and programs relating to biological and medical science.

**5) Participation in International Projects.**

The Belgian effort to participate in international community research programs, such as the European Nuclear Research Commission (CERN) or JET, the community research programs and Eureka, has been re-affirmed; it has also been affirmed that this effort must be sustained even if Belgian economy experiences setbacks.

## 6) Information.

The inventory of potential research will be systematically updated and a "technology museum" will be created in Belgium, with rooms for conferences and film screenings, and a department devoted to demonstrations; the entire installation will be modelled on the La Villette Center in France.

The policies proposed by Mr Verhofstadt, the Minister of Scientific Planning, are naturally reflected in the 1986 appropriations and in the budget projections for 1987.

The overall appropriations of the Belgian government for scientific research and technological development will go from 58.7 billion Belgian francs in 1985 to 57.5 billion in 1987, representing a decrease of 0.62 percent.

In the overall framework of the appropriations, the funds going to universities are constant in absolute values but they are decreasing in real terms if we take into account inflation and the rise in the number of students. Some of the restrictions are in any event compensated by an increase in basic research efforts.

Belgium is thus faced with a certain movement in funding from education to research. The budget for the National Scientific Research Fund (FNRS)—a structure similar to Italy's CNR, but without its own institutes or research centers—will go from 1.17 billion Belgian francs in 1985 to 1.21 in 1987, and the funds for medical research will go from 674 million in 1985 to 724 in 1987.

The expansion plan proposed by Mr P. Maystadt, the former Minister of Budget and Scientific Programming, has been superseded, as well as a fund provided for the renovation of industry. In their place, funds will be appropriated to finance the fiscal incentives for technological innovation in industry; on the other hand, the funds for prototypes will be drastically reduced (falling from 900 million in 1985 to 350 million in 1987).

Some scientific programs launched over the course of recent years and managed by government services for scientific planning (SPPS) are in their concluding phase (energy program, "telerivamento," and research in Antarctica). To the contrary, other programs have been launched: one on artificial intelligence with an appropriation of 150 million for 1987 and one for the life sciences sector with an endowment of equal value.

Space research remains among the favored sectors and funding for this sector will increase from 1.9 billion in 1985 to 2.2 in 1986, and 2.85 in 1987.

An innovation introduced by Minister Verhofstadt was the establishment of the Interuniversity Associations for Advanced Technologies (PAIT), the purpose of which will be to encourage scientific cooperation among the universities and between the universities and industry. The appropriations for the interuniversity associations, which will be

organized on the topics of the new materials, of optoelectronics, atomic physics, heterogenous catalysis, and genetics amount to 200 million Belgian francs.

The establishment of science parks—establishments that in part are already in existence in the region of Brussels and Louvain—also is being given particular importance. Their construction and expansion will be stimulated for the purpose of attaining closer connections between the university research centers and industry.

13331

## Great Britain: S&T Parks Listed

36980194b Rome NOTIZIE AIRI in Italian  
Oct 87 pp 39-41

[Article from: Invest in Britain Bureau, Department of Trade and Industry: UK Science Parks]

[Text] As of the end of 1986, there were 31 science parks in Great Britain employing about 5,300 people, the great majority of whom were scientists and researchers. The number of science parks in the United Kingdom is nonetheless growing because this year there are another seven parks already under construction, and construction plans for another six parks are being studied. The science parks operating in Great Britain respond to specific goals: to bring about an operating cooperation with the universities and other institutions specializing in research and to give rise to a transfer of technology to the business sphere. Science parks are of various sizes: on average, they comprise buildings covering one or two acres and they include university campuses of 70 to 120 acres.

Each science park functions in close collaboration with a large English university, while in the neighboring areas many leading-edge industries are operating and taking advantage of the presence of the science parks precisely to develop new technologies. Each English science park specializes in certain areas of research, and many of the services offered are shared.

The start-up of science parks in Great Britain began in 1972 due to the English government's desire to set up structures that would allow it to keep up with the competition, particularly the Japanese and Americans.

Another of the goals set by the government was also to attract foreign industrial groups so that, thanks to the presence of the science parks, they would create new businesses on English territory.

Numerous benefits are brought about by the creation of science parks: their presence permitted improved university training; the increase of degrees earned in technical-scientific disciplines; closer cooperation in the field of research and training between universities, industries, and specialized centers; the creation of new industries with advanced production; and installation of foreign

high-technology firms. The English science parks, according to Ian Dalton, Chairman of the UK Science Parks Association, help to develop new industry for the 90s.

Following is a list of the science parks operating in Great Britain, as well as those under construction, as of January 1987:

[The list shows the name of the park, the year in which it opened, the size in acres, the university to which it is connected, and the name and telephone number of the contact person. Asterisks in the original are not explained.]

Operating Science Parks

Name	Date Opened	Land Property	University Connection	Contact Person
1. Aberystwyth Science Park*	1985	6 acres	University College of Wales	C. Jenkins (0970-615779).
2. Antrim Science Park Belfast*	1986	74 acres	Queen's University & New University, Belfast	G. Dillon (0266-3655).
3. Aston Science Park Birmingham*	1983	25 acres	Aston University	H. Nicholls (021-359-0981).
4. Birmingham Research Park*	1986	12 acres	Birmingham University	Dr. D. Burr (021-471-4977).
5. Bolton Technology Exchange*	1985	4 acres	Bolton Institute of Education	D. Bromley (0204-361708).
6. Bradford Science Park (Listerhills)*	1983	11.75 acres	Bradford University	L. West (0274-733466).
7. Bridgend (Mid-Glamorgan) Science Park	1985	90 acres	University of Wales and Wales Polytechnic	A. Brown (0222-820820).
8. Brunel Science Park Uxbridge*	1985	6.4 acres	Brunel University	P. Russell (0895-72192).
9. Cambridge Science Park*	1973	130 acres	Trinity College, Cambridge	H. Bennett (0223-841841).
10. Chilworth Research Centre, Southampton*	1984	25 acres	Southampton University	Prof. Large (0703-559122).
11. Durham (Mountjoy) Research Centre*	1985	5 acres	Durham University	Dr. E. Howells (0385-64971).
12. East Anglia Science Park, Norwich*	1984	12 acres	University of East Anglia	P. Lannigan (0603-56161).
13. Heriot-Watt* Research Park, Edinburgh	1972	56 acres	Heriot-Watt University	I. Dalton (031-449-5111).
14. Highfields Science Park, Nottingham*	1984	18 acres	Nottingham University	J. Webb (0602-506101).
15. Hull Innovation Centre*	1984	3 acres	Hull University	D. Geekie (0482-46311).
16. Keele University Science Park	1986	15 acres	Keele University	Dr. D. Cohen (0782-62111).
17. Kent R&D Centre Canterbury	1986	10 acres	University of Kent	B. Watts (0227-66822).
18. Leeds (Springfield Hse) Innovation Centre	1983	2 acres	Leeds University	P. Wilbourn (0302-66865).
19. Loughborough Technology Centre*	1984	3 acres	Loughborough University	D. Sturgis (0533-87131).
20. Manchester Science Park*	1984	15.5 acres	Manchester University & Poly., MBS & UMIST.	T. Broadhurst (061-226-1000).
21. Menai Technology Enterprise Centre*	1986	1 acre	University College of North Wales, Bangor	D. Jones (0248-354103).
22. Merseyside Innovation Centre*	1982	2 acres	Liverpool University & Polytechnic	A. Rimmer (051-708-0123).
23. Newtech Science Park, Clwyd*	1985	1.5 acres	NE Wales Institute	Dr. J. Allen (0244-822881).
24. St Andrews Technology Centre	1984	0.74 acres	St Andrews University	Dr M. Shepherd (0334-76161).
25. South Bank Technopark, London*	1985	1.7 acres	South Bank Polytechnic	J. Jeffers (01-928-2900).
26. Stirling University Innovation Park	1986	14 acres	Stirling University	R. Clark (0786-70080).



**Operating Science Parks**

Name	Date Opened	Land Property	University Connection	Contact Person
27. Surrey Research Park, Guildford*	1984	70 acres	University of Surrey	Dr M. Parry (0483-579693).
28. Sussex University Science Park, Brighton	1985	25 acres	University of Sussex	J. Golds (0273-678238).
29. Swansea Innovation Centre*	1986	3.4 acres	University of Wales	N. Carnie (0792-586715).
30. Warwick Science Park, Coventry*	1984	24 acres	University of Warwick	D. Rowe (0203-418535).
31. West of Scotland Science Park, Glasgow*	1983	61.5 acres	Glasgow & Strathclyde Universities	A. McNicoll (041-946-7161).

**Science Parks Under Construction**

[The date shown is the date the park association was formed.]

Name	Date Opened	Land Property	University Connection	Contact Person
1. Aberdeen Science & Research Park	1987	60 acres	Aberdeen University	P. Miller (0224-641791).
2. The Burn Park Tech. Centre, Sunderland	1987	2 acres	Sunderland Polytechnic	P. Calvert (091-487-2711).
3. Cardiff Technology Centre*	1987	1.5 acres	University College, Cardiff	J. Andrews (0222-499022).
4. St John's Innovation Centre, Cambridge*	1987	19 acres	St. John's College	C. Johnson (0223-338627).
5. Salford University Business Park*	1988	5 acres	Salford University	T. Wilby (051-933-2020).
6. Sheffield Science Park*	1988	5 acres	Sheffield University	P. Wilbourn (0302-66865).
7. York University Science Park	1987	3 acres	University of York	R. McMeeking (0904-430000).

13331

**ANVAR: 1987 Status Report, 1988 Objectives Detailed**

36980204a Paris AFP SCIENCES in French  
4 Feb 88 pp 1-5

[Article: "ANVAR [National Association for the Implementation of Research] Aids to Innovation Increased by 7.7 Percent in 1987"]

[Text] In 1987, ANVAR granted Fr1 billion in aids to innovation, i.e. 7.7 percent more than in 1986, the organization indicated in a communique published on 29 January.

A total of 3,279 grants were involved, with an increasing share allocated as aid to the creation of new businesses. Small and medium- size businesses, on which the agency is now focussing its resources, got the lion's share with Fr860.1 million (+ 7 percent) in 2,720 grants, including 1,550 to new clients.

Despite the reduction of its budget allocation (from Fr587.3 million in 1986 to Fr566.5 million), ANVAR was able to increase its aids to innovation, thanks in particular to increasing repayment of previous aids (Fr292 million) and to a Fr30-million allocation for aid to innovative software.

ANVAR pointed out that an increased proportion of its aid went to help the creation of new businesses, and that preliminary aid to the launching of innovations (APLI) was off to a good start; this type of aid was introduced last spring and 78 projects received Fr35.8 million.

**1987 ANVAR Highlights**

	Number of projects	Million Fr
<u>Aid to innovation</u>		1,014.70
-Aid to innovation projects (API)	1,565	822.1
-Preliminary aid to the launching of innovations (APLI)	78	35.8
-Aids to innovation services (ASI) (including independent inventors)	1,495	83.8
-Additional subsidies		
— SRC/CRC [research contractors/collective research centers]	62	51.6
— COFACE [French Foreign Trade Insurance Company]/ANVAR	79	8.0
-Youth innovation awareness efforts	1,114	13.4
including PAE	547	2.6
Summer scholarships	56	0.3
PIJ	87	1.2
APIES	424	9.3

# 1987 ANVAR Highlights

	Number of projects	Million Fr
<u>Implementation of public research</u>		
Number of files in management portfolio, from some 30 research centers	2,690	
including CNRS [National Center for Scientific Research]	1,882	
Universities	357	
French patent applications	136	
Foreign patent applications	1,449	
Transfer agreements signed	161	
Royalties received from 523 licenses	—	17
Reminder: Aid to laboratory innovation (API)	173	71.8

The main sectors which benefited from ANVAR aid in 1987 were data processing (Fr98.5 million for 139 projects), the agribusiness sector (Fr70.5 million, 147 project) and the biomedical sector (Fr70.5 million, 109 projects). Geographically, the Paris area ranks first for the aids received, with Fr229.3 million for 534 projects; it is followed by the Rhone-Alps region (Fr101.6 million for 341 projects).

For 1988, ANVAR resources will amount to about Fr1 billion, with an initial budget allocation of Fr623 million, repayments estimated at Fr300 million, and a specific data-processing allocation of Fr30 million, the rest coming from various sources. As far as businesses are concerned, the objective is to grant Fr740 million in aids at regional level and Fr150 million at national level, with a projected 3,200 clients including 1,550 to 1,600 new ones.

A special effort will be made to help the creation of new businesses (objective: 500 creations, i.e. about one third of the new clients), to promote the European component in the technological efforts of small or medium-size businesses (objective: 35 percent of the projects) and to promote technical cooperation between small or medium-size businesses and research organizations (objective: 35 percent of the projects).

In addition to aids to innovation, ANVAR manages a portfolio of 1,681 French and 6,857 foreign patents: on behalf of research organizations, it negotiates and manages contracts with businesses and contracts for patent utilization and patent licenses (a total of 523, at the rate of about 100 per year), which brought in close to Fr17 million in royalties in 1987.

# ANVAR 1988 Objectives (22 January 1988)

## Available Resources

For 1988, ANVAR resources will amount to about Fr1 billion:

- Fr623 million in budget allocations;
- Fr300 million in repayments (estimated minimum);
- Fr30 million as a specific data-processing allocation;
- plus program authorizations taken over and miscellaneous.

## Quantified Objectives

- a. Fr740 million in aids to businesses (API + APLI + ASI) at regional level;
- b. Fr150 million in aids to businesses (API + APLI + ASI) at national level;
- c. Between 1,550 and 1,600 API projects undertaken regionally (compared with 1,400 completed in 1987), i.e. about 3,200 projected clients for 1988;
- d. Between 1,550 and 1,600 new clients expected (compared with projections of 1,275 clients in 1987 and 1,550 actual clients);
- e. Increased support to SRC/CRC—research contractors/collective research centers—(Fr100 million) based in particular on research contracts completed on behalf of small and medium-size enterprises and on the completion of studies for transfers between sectors;
- f. 1,000 IET (Technological Information of Businesses) operations; 250 researchers to work in businesses.

## Special Effort Bearing On:

- a. The creation of businesses, with an objective of 500 (i.e. one third the number of new clients);
- b. Promotion of the European component in the technological efforts of small and medium-size businesses (objective: 35 percent of all projects);
- c. Promotion of technical cooperation between small and medium-size businesses and research organizations (objective: 35 percent of all projects);
- d. Reinforcement of the ties between each regional delegation and its environment: public institutions (local communities, CCI, etc.), financial institutions (banks, regional participation companies, etc.), and technological organizations (technological poles, universities, etc.).

ANVAR: Allocations, Commitments, Repayments (Millions of Francs)

Year	Program Authorization Allocations	Repayments	Total Commitments
1980	726.4	—	548.2
1981	479.1	—	659.5
1982	640.0	22.4	632.0
1983	813.9	51.2	830.1
1984	678.7	97	866.8
1985	906.3	148.8	1,102.6
1986	587.3	243	940.3
1987	566.5	292	1,014.7*
1988	623	300**	—

(\*) Provisional figure (\*\*) Minimum projections

—For 1988, ANVAR will have a budget of about Fr1 billion (initial budget allocation, estimated repayments, program authorizations taken over, specific data-processing allocation, etc.).

—In 1987 and in 1988, ANVAR received a specific Fr30-million allocation to support innovative software; this allocation is not included in the agency's initial program authorization allocations.

1987 Breakdown of Aid to Innovation Projects (API) per Innovation Sector (ANVAR Total)

Sectors	1987	
	Number of Projects	Million Francs
1. Agriculture	94	40.1
2. Fishing and fish farming	23	7.0
3. Agribusiness	147	70.5
4. Wood	34	11.6
5. Paper	8	8.0
6. Leather and shoes	10	2.8
7. Microorganic ferments, enzymes	3	1.8
8. Steelmaking, metallurgy	9	5.7
9. Foundry, metalworking	30	14
10. Mechanical industries	76	27.9
11. Mining and minerals	8	5.8
12. Building materials	16	7.7
13. Building industry	59	21.5
14. Public works	19	13.2
15. Glass and ceramics	16	5.3
16. Composites	19	10.4
17. Plastics and rubber processing	20	7.3
18. Chemicals	29	11.2
19. Parachemicals	20	14.8
20. Textiles and clothing	51	27.9
21. Pharmaceuticals	32	35.4
22. Primary energy sources	9	1.6
23. Electrotechnology	45	36.8
24. High-temperature materials	24	17.1
25. Water, effluent and waste	26	10.0
26. Watch-making, optical	11	6.6
27. Biomedical	109	70.5
28. Measurement and testing	68	24.1
29. Laboratory equipment	13	4.6
30. Security	29	14.1
31. Electronics	62	37.2
32. Data processing	139	98.5
33. Automation	28	16.6
34. Offshore, space	5	3.5
35. Consumer products	143	51.1
36. Graphic arts	20	16.1

1987 Breakdown of Aid to Innovation Projects (API) per Innovation Sector (ANVAR Total)

Sectors	1987	
37. Handling equipment	26	11.9
38. Packing and packaging	53	20.8
39. Transportation	71	38.5
40. Tertiary industrial sector	1	0.1
Total	1,605	829.6
Projects not included above	38	28.3
API Total	1,643	857.9
9294		

**Ciba-Geigy Diversifies in Biotech, New Materials**  
36980204b Paris L'USINE NOUVELLE in French  
11 Feb 88 p 18

[Article by Caroline Verhack: "Ciba-Geigy: High Tech Takeoff"]

[Text] Ciba-Geigy is asserting itself in biotechnologies and new materials by dint of acquisitions and agreements. It strengthens its position as a European leader for advanced composites.

Ciba-Geigy is quietly putting on a new face. It is not launching spectacular takeover bids like its colleague in Basel, Hoffman-La Roche. Instead, it is multiplying acquisitions and agreements in two high-tech sectors: biotechnologies and composite materials. The new technologies are thus progressively displacing traditional activities. And for the first time last years, the revenues of the plastics division exceeded those from agrochemicals and almost equalled those from pharmaceuticals.

The Basel chemical company became interested in biotechnologies, and in particular in antibiotics, in the 1950's. But it is in 1983 that it got a push in the right direction, with the inauguration of its Basel research center equipped with pilot facilities for the fermentation and isolation of cell substances. Finally, in 1986, Ciba-Geigy, which already had ties with the U.S. company Genentech, entered into a partnership with another U.S. company, Chiron, a pioneer in genetically engineered vaccines. Today, biotechnology accounts for 20 percent of the pharmaceutical research budget and 70 research jobs. The main lines of research are: inflammatory diseases, infectious diseases (AIDS, hepatitis, flu, etc.), cardiovascular diseases, metabolic diseases, cancer, etc. Prof Jakob Nesch, head of pharmaceutical research in Basel, remains however very discreet as to the marketing calendar of new substances. For many of these, such as hirudine (used to treat inflammatory diseases) or interferon (treatment of cancer and infectious diseases), the Swiss group is competing with many laboratories, such as the French Transgene, which is quite advanced as far as hirudine is concerned. It is known, however, that

research on herpes, malaria and AIDS has reach the development stage; an AIDS vaccine developed jointly with Chiron is now undergoing clinical testing.

Ciba-Geigy is not a novice either in the field of composite materials. Actually, it was in Basel that epoxy resins (araldite), which have many industrial applications, were discovered 50 years ago. From this traditional activity, the Basel chemical manufacturer went on to the second component of composite materials (specialty fabrics, prepregs, honeycomb, panels), either through the creation of production units (one in England and three in the United States) or through partnerships (joint venture with the Japanese Asai), or again by taking over, in 1980, a former Lyons silk manufacturer which has now become the French leader in woven composite fibers: Brochier (Fr260 million in sales in 1985), which holds three fourths of the French market for high-performance composites. In that field, Ciba is the European leader (ahead of Hercules, ICI [Imperial Chemical Industries], and BASF [Baden Aniline and Soda Factory], etc.) and it further strengthened its position late in January when it acquired Heath Techna (Fr400 million in sales), a U.S. company specialized in aircraft interior furnishings made of composite materials (luggage compartments, wall and floor coverings, etc.). Indeed, the aeronautical sector is now the main market for advanced composites. And the group supplies most European aircraft manufacturers: Airbus (A320), Fokker, Dassault (Falcon 900), British Aerospace, etc.

Positioned in the middle of the composites processing line, Ciba-Geigy is not planning, for the time being, any upstream integration toward fibers, but it might go downstream and sell processes to help its non-aeronautical clientele manufacture parts. An idea which Jean Freidel, chief executive officer of Brochier, finds attractive.

In the meantime, composite materials, which account for one third of the plastics division revenues, are about to gain the ultimate recognition at Ciba, where they will become an independent product center within the division. And they will receive some of the Fr6 billion (10 percent of sales) that the group will spend this year, both to increase its capacity and to improve productivity and

security. Thus, after the expansion of the European and U.S. composite units, the third European prepreg factory, built in Germany, will start production in 1990.

#### Pharmaceuticals Still in the Lead

##### Breakdown of 1987 Sales (Total: Fr63 Billion)

	Billion Francs	Percent
Pharmaceuticals	18.9	30
Plastics and additives	14.5	23
Agricultural products	13.9	22.1
Colors, dyes, and chemicals	9.2	14.6
Electronic equipment	3.3	5.2
Miscellaneous	3.2	5.1

9294

#### 1988-91 Research Program, Budget of Karlsruhe Nuclear Research Center

3698m231 Bonn TECHNOLOGIE

NACHRICHTEN-MANAGEMENT

INFORMATIONEN in German No 472, 29 Jan 88 p 8

[Text] The Karlsruhe Nuclear Research Center (KFK) has presented its new medium-term project and financial plan for the years 1988-1991. According to this plan, research activities in areas such as environment, materials, nuclear fusion technology, micro-processing, and robotics are to be further expanded. Maintaining nuclear technology research and development projects, from a point of view of international research and competition policy, is also a fundamental element of the plan. In its role as major contractor of the FRG's international engagements in nuclear research, the KFK coordinates cooperation with East Bloc countries, is a contractual partner with U.S., Japanese, and Korean research centers, makes a substantial contribution to cooperation between the FRG and Brazil, and is also a key partner with Britain, France, Belgium, and the Netherlands.

The KFK's overall budget is about DM718 million, which includes a total of DM84 million in funds granted on a trust basis to participate, for example, in the activities of the Laue-Langevin institute in Grenoble, to carry out project commissions and for special financing. After deducting its own earnings of about DM131 million, the KFK's contributions from the government amount to DM587 million.

The current budget program continues the transformation of the KFK's project structure which started at the beginning of the decade. In the past, the center of the research and development work was to be found in nuclear engineering which required up to 80 percent of available funds. Considering that nuclear engineering has been introduced into the market successfully, these activities are to be reduced by about half by the beginning of the 1990s and concentrated mainly on longer term developments, especially in the field of fuel cycle

and safety in large fast-breeding reactors. Most of these activities are connected in their objectives and scope to international joint ventures, in part supported by government agreements.

Additional research priorities besides energy technology are to be found in the environmental and safety areas, while environmental technology has been coordinated within a "project for the control of emissions of harmful substances in the environment" since the end of 1987. The relevant activities here range from researching sources of emission of harmful substances and how they spread in the ecosphere to developing highly technical precipitation plants for harmful substances. Cooperation at an early stage with industrial users is of primary concern.

Safety-oriented research projects for light water reactors are also carried out within the "environment and safety" priority program. They concentrate substantially on contributions to phase B of the FRG risk study concerning nuclear power plants which should be used, based on the latest scientific findings, to assess the risk of an accident caused by the core melting. Many connections exist in this field with research institutes in the United States, Canada, Japan, Korea and with the European Community research institute in Ispra.

The various contributions of different KFK institutes to industrial automation have also been tightened up organizationally by grouping them together in their own primary working area. With the title, "Highly Flexible Industrial Automation," new industrial working areas are intended to be opened up to remote control technology originally meant for nuclear engineering applications, by connecting it adequately with modern data processing and sensor technology. The international standing of this effort stems, for example from the fact that the KFK developed a maintenance robot a large, 9-meter long, computer-controlled device, for the Tokamak Fusion Test Reactor in Princeton, New Jersey.

The micro-processing field also is relatively new. By combining an X-ray based photolithography with galvanoplastic molding a manufacturing method originally planned for uranium enrichment enables to mass-produce complicated micro-components that until now could not be manufactured mechanically. It will be possible to use the new type of production process in many sectors. The structural conditions necessary for this priority activity field to be expanded are currently being set up together with partners from private industry.

Solid-state physics and materials research at the KFK is oriented mainly toward the requirements of technical projects and is also entrusted to project organizations in these cases. The physics of real surfaces and the development of high performance materials are particularly

important working areas beyond the projects. The fundamentals and technology of superconducting materials, for example form a working field on its own. The KFK is a leader in the FRG in developing new high temperature superconductors.

The KFK's basic research concentrates on the field of nuclear and particles physics. Special attention should be given here to the KFK's participation as a prime contractor in a large-scale international experiment on neutrino physics, whose results will be decisive to answer the intensively discussed question of neutrino masses.

The nuclear research center is also used by its partners as a project contractor in many areas, because of the broad spectrum of the disciplines the institute is involved in and its all-encompassing infrastructure. In addition to project organization on behalf of the Baden Wuerttemberg Land in the environmental field, there are others on behalf of the government related to water technology, manufacturing engineering and medium energy physics.

The technological developments that the KFK has been transferring successfully to medium-sized industry and small enterprises through a coordination center for several years is particularly noteworthy. Other than in large-scale projects, where entire technology packets are processed in close cooperation with industry according to the objectives of research policy, technology transfer takes place with the industrial exploitation of results that come about on the fringes of large-scale projects and are not followed up any further in that connection. The technical priorities of technology transfer are thus oriented toward the institute's broad spectrum of know-how and experience.

08702

## TECHNOLOGY TRANSFER

**European Parliament Approves Research Programs, Italian Role Outlined**  
3698m223 Turin MEDIA DUEMILA in Italian  
No 1, Jan 88 pp 113-115

[Article by Giampiero Gramaglia: "EEC News: 'BRITE' Days and COMETT Projects"]

[Excerpts] The European Parliament has voted on a number of EC research programs that are part of the 1987-91 5-year plan launched last summer by the [EC] research council at ministerial level.

The parliament's position on these programs is as follows:

1—ESPRIT: the parliament approves the second stage of this information technology program and recommends that this initiative contribute to a greater cohesion

within Europe by favoring lesser developed areas, that it support small and medium-size industries, and that it take into account the opinions expressed by the social forces and create new jobs.

2—RACE: the parliament, backed by the [EC] Commission, unanimously objects to the way the research council wants to implement the telecommunications program, and asks that action be taken to ensure that this initiative does not increase existing gaps between EC areas.

3—BRITE: the parliament agrees with the changes suggested by the commission for this program, aimed at making the new technologies accessible to traditional industry. Specifically, it agrees to the following: allocation of an additional 60 million ECU's to this project; priority for initiatives that have the participation of at least two private organizations in two different countries; access to the program for the EFTA countries—Switzerland, Austria, Norway, Sweden, Finland, and Iceland; above all, it recommends that this program contribute to European cohesion and improve employment levels.

4—In connection with the research program in aid of developing countries, the EC institutions disagree, primarily from the legal viewpoint; the parliament wants a stronger research program with participation of the countries involved and of the international organizations representing the Third World.

The Economic and Social Committee (CES), the advisory body representing all Europe's social forces, also expressed its opinion recently on the projects of the 5-year research program.

In connection with ESPRIT, the committee agrees to continue with the second stage, allocating to this financing of 1.6 billion ECU's, while suggesting that small and medium-size firms finance over 50 percent of the total project value; the committee also recommends the integration of research at national and European level and user involvement in the projects.

For DRIVE—a project on road safety—the committee is in favor of rapid implementation, pointing out that in Japan a joint venture was launched on 1 October 1985 in the sector of data processing applied to road transportation, with the participation of the Ministry of Trade and 13 automobile manufacturers and electronics firms.

The DRIVE project must also take into account EC transportation policy and social aspects of road safety.

The EC has launched "STAR" and "VOLOREN," two projects for developing new technologies and renewable energies in the lesser developed EC areas. Italy will derive the greatest benefit from these programs.

STAR and VALOREN were approved at a meeting of the Council of Ministers of the EC held in Luxembourg in October 1986. A year later the EC Executive Committee launched the new initiatives.

STAR will receive financing of 780 million ECU's from the EC, of which 250 million ECU's will be for Italy. VALOREN will receive financing of 400 million ECU's, of which 125 million ECU's will be for Italy. The financing for these two projects, which will benefit regional administrations, district and local administrations, private enterprises, cooperatives, and individuals, will come from the EC Regional Development Fund.

The European Commission has selected the first six projects of the "BRAIN" research program [Basic Research in Adaptive Intelligence and Neurocomputing] following a recommendation by the leading EC experts in the sector.

The objective of "BRAIN" is to develop research on the functioning of the brain and the possibility of reproducing its mechanism, an initiative leading to European "artificial intelligence." A negative point for Italy is that this country is not going to take part in the six projects just launched, either as sponsor or participant.

The European Commission has suggested that the EC council of ministers should revise the policy of the 1985-9 biotechnology project and increase financing by 20 million ECU's, with the following recommendations: intensification of training in all the sectors of the present program, integration of the Spanish and Portuguese laboratories; expansion of bio-informatics activity; increased research on techniques of risk evaluation; and implementation of feasibility studies for the next biotechnology project for 1990-94.

The European Commission has suggested to the EC council of ministers to reorganize the Community Center for Research [CCR], grouping together various institutes in different countries, such as the Ispra laboratory near Varese.

Reorganization should start this year after the council's decision. Therefore, from now on the CCR will operate in the following four areas:

- 1—implementation of specific multi-annual programs outlined in the EC 5-year plan;
- 2—support for scientific and technical research to assist the European Commission in various activities;
- 3—contracts for research or services with private and public external partners;
- 4—preliminary research for the study of new sectors of research and to back up European technology strategy.

At a meeting held in mid-December the EC council of ministers gave final approval for the "RACE" telecommunications project, whose administrative procedures still have to be defined (the "Twelve" have kept for themselves decisionmaking powers that the European Commission, with the support of parliament wanted to obtain.

"RACE" (Research and Development in Advanced Communications for Europe) aims to promote by 1991, with a budget of 5500 million ECU's, a consistent program of initiatives including completion of a European integrated wideband telecommunications system.

Research will be carried out on a supranational basis and will be open to industry, telecommunications companies, and postal administrations. The European Community will cover about half its cost. "RACE," whose pilot phase is already completed, aims to be for EC telecommunications what ESPRIT is in the data processing sector and BRITE is in the innovation of traditional industry.

Geneva, Paris, and Tokyo—The International Advisory Committee for Radiocommunication has officially approved the new European standards "Mac-Packet"—for high-definition television (HDTV). This was done mid-November in Geneva but the news has not yet been officially confirmed.

"Mac-Packet" has been given preference over the Japanese "Hivision" standards developed with some support from the United States, but unsuitable for the majority of systems now in existence in the world, including the American systems.

Jean Caillot, general manager of Thomson International, who took part in the Geneva meeting, declared in Paris that: "Without waiting for the 1988 deadline set by the International Radiocommunication Advisory Committee, Europeans have succeeded in having proposals made by six countries (Britain, France, the FRG, Italy, Belgium, and The Netherlands) and supported by the EC, accepted as a proposal for a world standard."

It was also made known during the same period in Tokyo that the Japanese have a flexible attitude toward the European system and beginning in 1988 are willing to set up a joint work team with the community to align Mac-Packet with Hivision, thus avoiding a "standards war." The idea of a joint team comes from Michel Carpentier, the general manager for new technologies of the European Commission. The "founding fathers" of the European system include such names as Philips, Thomson, Thorn-Emi, and Bosch; the Japanese system is backed by NHK, the national television network, Sony, and the American CBS.

08707

#### **Montedison to Head Consortium for Soviet Petrochemical 'Pole'**

*3698m221 Milan CHIMICA OGGI in Italian  
No 12, Dec 87 p 66*

[Text] The Soviet oil minister, the Montedison Group, and the Occidental Petroleum Corporation have signed a preliminary agreement for a joint venture with the aim of creating a petrochemical center at Tenghis in the Ural

Region, north-east of the Caspian sea. This center will exploit raw materials—ethane and hydrocarbons—coming from the local oil fields.

Specifically, Montedison was given the task of establishing the consortium that will construct the petrochemical center, which will be one of the largest in the world. The annual capacity of the center will be 500,000 tons of polypropylene and an equal amount of polyethylene, as well as other types of polymers, copolymers, and composites, and 1 million tons of sulphur that can be used to produce fertilizers.

08801

**Text of Italy-Poland Automobile Agreement  
Reported**  
*3698m224 Rome GAZZETTA UFFICIALE DELLA  
REPUBBLICA ITALIANA in Italian  
No 11, 15 Jan 88 pp 219-220*

[Text of memorandum of understanding between Italy and Poland on the development of economic, industrial, and technical cooperation between the two countries in connection with the automobile industry; signed in Rome on 19 November 1987]

[Text] Rome, 19 November 1987

**Protocol**

The government of the Republic of Italy and the People's Republic of Poland

With reference to the agreement between the governments of the Republic of Italy and the People's Republic of Poland on the development of economic, industrial, scientific, and technical cooperation signed on 17 January 1974 and to the agreement on economic cooperation signed on 21 December 1984,

With the intention to increase economic cooperation between the two countries, and taking into consideration the positive results that have been obtained heretofore in connection with Italo-Polish cooperation in the automobile industry and desirous to develop it further,

And also acknowledging the fundamental role played by cooperation in the automobile industry in the area of economic relations between Italy and Poland,

hereby agree as follows:

**Article 1**

The contracting parties express their satisfaction on the progress of Italo-Polish cooperation in the automobile field, particularly concerning long-term agreements that were reached recently by the leading automobile industries of the two countries.

**Article 2**

The contracting parties, hereby assume responsibility, with all means available to them and taking the necessary initiatives, for facilitating the development of economic cooperation in the aforementioned field and for the implementation of joint cooperation programs within the limits of the regulations in force in the respective countries.

**Article 3**

In connection with credit, the Italian authorities are willing to give the necessary authorization for the granting of commercial loans intended for implementation of the agreements reached between the automobile manufacturers of the two countries mentioned in article 1 hereto.

**Article 4**

The creation of cooperation between the Republic of Italy and the People's Republic of Poland provided for in the present memorandum of understanding will, if necessary and on request by one of the contracting parties, be examined by the joint commission established on the basis of the agreement between the Republic of Italy and the People's Republic of Poland concerning development of economic, industrial, scientific, and technical cooperation, signed in Rome on 17 January 1974.

**Article 5**

The present memorandum will have effect from the date of signature.

Done in Rome on 19 November 1987 in two copies, each in Italian and Polish, both of equal validity.

[Signed:] [Signed:]  
for the Italian Republic for the People's Republic of Poland  
08801



## CNET of France Develops 1-Micron CMOS, Flat Panel Technology

### New Flat Panel Technology

36980184a Paris *ELECTRONIQUE ACTUALITES* in French 12 Feb 88 pp 1, 13

[Article by D. Girault: "More Than A Simple Technology Transfer, A CNET/MHS Cooperation"]

[Text]

### Two-Level Metal 1 $\mu$ m CMOS Technology for MHS

On 23 February, J. P. Poitevin, CNET director, and G. Dumas, CEO of Matra-Harris Semiconducteurs (MHS), will present the results of the 1  $\mu$ m CMOS technology transfer from CNET Grenoble to MHS. This program, initiated in December 1984, will thus have been brought to term: it consisted of a cooperation agreement signed between the two parties, regarding the transfer of a micron-sized CMOS technology that would culminate in the fabrication of Telecom circuits. In practical terms, CNET Grenoble would be responsible for building the circuits in its clean room, such that the process could be validated by MHS. A responsibility which it fulfilled.

The transfer of the 1  $\mu$ m, two-level metal (tungsten/aluminum) process, named Super CMOS, which was perfected by an 80-person team (out of a total of 300 employees) at CNET Grenoble, is now underway at MHS' Nantes location. The test circuit designed by MHS, a 64 Kbit SRAM (static RAM) memory, fabricated entirely by CNET Grenoble and validated by MHS, will be shown at the Salon des Composants with commitments of high level performance: 10  $\mu$ A consumption at less than 5 V in standby, and approximately 20 ns transfer time. Volume production of this SRAM is planned for the end of this year together with the ASIC shop, at a complexity of up to 50,000 gates. Beginning next year, Telecom circuits will be offered by MHS; the latter will undoubtedly continue its collaboration with CNET, which in turn is focusing its studies on this type of circuits. However, this cooperation would be supported by MHS, whereas the Super CMOS technology transfer was considered as a subsidy awarded to MHS, and which would thus be filtered through DGT (General Directorate for Telecommunications)/DAII (Directorate for Industrial and International Affairs).

In addition to Telecom circuit studies, which will become increasingly important at MHS as the ISDN (integrated services digital network) field becomes better defined, research into 0.5  $\mu$ m technology is carried out jointly with CNET as part of Spectre, an Esprit sub-program which also involves SGS-Thomson Microelectronics and British Telecom. MHS however, will find it absolutely necessary to change equipment for this purpose, particularly in photolithography.

### Process Suitable for Telecom Circuits

The SuperCMOS technology was developed by CNET Grenoble to fabricate Telecom circuits, SRAM memories, and for ASIC; also planned is future production based on reliable capacitors obtained by increasing the density of inter-poly oxides. Still to be expanded is the range of supported voltages, since analog circuits require +5/-5 volts instead of the single 5 volts of logic circuits. Joint efforts are being made with CNET to fabricate such circuits before the end of next year.

This policy directly follows the strategy adopted by MHS since its inception, which consists of mixing COFIDECS and analog products: it has thus produced 3  $\mu$ m COFIDECS; the collaboration with Intel, Cimatel in this instance, (jointly reported by both parties last year) also resulted in the acquisition of Telecom circuit know-how, which MHS is now using.

The new products to see the light of day, and that have been under study since the first quarter of last year, will be the ISDN S interfaces, which are scheduled for sampling during this year's fourth quarter. Requiring the transfer speed provided by 1  $\mu$ m CMOS (80 MHz toggle rate frequency compared to 45 MHz with the "older" 2  $\mu$ m, two-level process) in order to satisfy the ISDN protocol, these components increasingly integrate two HDLC (high level data line control), one FIFO register, one microprocessor, and a DMA (direct memory access) (which also implies the use of a line width of the order of a micron).

A speed adapter for the ISDN will be introduced on the market in 1988. The communication protocols and associated components will thus increasingly constitute a development direction for MHS, aimed both at "institutional" telecommunications and at industrial and military data transmission.

### Practically All Products Will Be Transferred as SuperCMOS

All current MHS products will be fabricated as SuperCMOS, except the very fast SRAM memories with the "four-transistor" base cell, which will be produced with the 1.2  $\mu$ m CMOS Cypress one-layer process. All eight-bit (Intel type) and 16-bit (from the NEC agreement) controller models will be fabricated as 1  $\mu$ m one-layer CMOS, a process derived from the SuperCMOS. Moreover, in addition to the aforementioned Telecom circuits, a new family of gate arrays with as many as 50,000 gates will be placed in production in September/October together with the 64-Kbit SRAM memory which was used to test the final operation of the 1  $\mu$ m two-level CMOS technology; this a "six-transistor" memory. It will be followed by a 256K model; however, some uncertainties persist regarding greater memory density with respect to the process being used. This process should be undergoing some shrinkage, which

under present conditions proves to be impossible without completely changing the production equipment used by MHS, which the latter does not plan to carry out immediately, preferring to derive the greatest possible return from its production equipment investments by using the Cypress 1  $\mu\text{m}$  CMOS. This is of course one of the difficulties raised by technology transfers between "public" laboratories, concerned with consistency at all costs, and "the private sector," which must consider the "money" factor and consequently make maximum use of installed facilities.

It is notable that the first 64K SRAM was obtained at CNET Grenoble last summer, that the qualification phase of MHS equipment (by CNET engineers) has now been reached, and that volume production of the 64K SRAM is planned for the end of the year.

Moreover, silicon compilation will also be undertaken, with SCS' GDT and Genesyl compilers being in their calibration phase. Genesyl will be reserved for custom circuits requested by customers, whereas GDT, which is more difficult to handle, will be reserved for internal studies at MHS. This requires the generation of technical files, among which the design rules, correlations with simulations, and comparison of simulator behavior with real conditions through the use of test circuits.

#### More Problems to Control

Technology transfer always raises problems, and this one is no exception. To simplify, consider the key points of SuperCMOS. This process allows the fabrication of a double interconnection level, with the difference that the first level consists of tungsten. As of now, the tungsten is deposited by sputtering. But for the tungsten deposit to be more efficient than the aluminum one, it has to be deposited chemically, by the CVD method (chemical vapor deposition). MHS is placing great hope on this approach, but today, the CVD method is still only in the research stage. This is one of the crucial problems to be solved. MHS and CNET have thus decided to buy a specific machine for this tungsten stage, a machine which must be successful in order to achieve contact stacking.

Moreover, the major problem of intermetallic dielectric planarization remains unsolved, since it is apparently not obvious that CNET's technology can be transferred to MHS. Lastly, the alignment and tracking control (dimension tolerances) developed CNET uses an SRA 100 photorepeater and a 10X stepper. Its adoption has led MHS to buy its own steppers (six or seven, for a total purchase price of 7-10 MF). This, in addition to the tungsten depositing machine 5-7 MF) and the equipment used to achieve planarization. The photolithography technique are also being evaluated, with a CNET engineer currently working to correlate the experimental and existing equipment at MHS.

The device must support its voltages with a standby current  $10^{-9}$  times lower than the operating current. But MHS and CNET did not adopt the same steps to begin their process, with MHS attempting to use materials derived from the Cypress fabrication process. The latter forces MHS to perform successive "thinnings," which places a limit on the process' validity for obtaining acceptable later diffusion at 1  $\mu\text{m}$ . CNET in turn, proposes a better solution, which proceeds through successive thickenings of the elementary design. Here again, a latent problem remains to be solved.

All in all, however, MHS intends to retain 80 percent of its equipment for its production lines. As we can see, every technology transfer has to overcome its own difficulties, and if the transfer does take place, several problems still remain to be solved before the technology as a whole is operational.

**CMOS Process Transferred to Matra Harris**  
*36980184a Paris ELECTRONIQUE ACTUALITES in French 5 Feb 88 pp 1, 13*

[Article by D. Levy: "CNET's Active Matrix Flat Color Screen Moving Toward Production"]

[Excerpts] The 1987 CNET Prize, intended to reward outstanding work at the National Center for Telecommunication Studies, has been awarded by Mr Longuet, PTT minister, to the CNET Lannion B group which designed and built an active matrix flat screen for color imaging. The originality of this work rests in the technology developed by the team, a technology which uses the same tools used in manufacturing color filters, and transistor matrices with only two masking levels. Despite our industrial lag in this active matrix flat screen field—the Japanese, who dominate this sector, already produce pocket television sets with such a screen, CNET believes that the simplicity of its fabrication process, which promises reduced costs and higher yield, is likely to assure the competitiveness of this technology against its opponents. This is especially true since the actual takeoff of the applications market (automobile instrumentation, data and telecommunications terminals) is not expected before 1992.

Hence, the essential step of installing a pilot line (the unofficial agreement has been granted) which would allow fabrication yield determinations for small batch screen productions. An industrial production line could be installed in parallel. Discussions are underway with SAGEM about some form of association with CNET for these projects.

In the race to replace the cathode ray tube, and to meet the display demands of new markets (communication terminals, vehicle instrumentation), the liquid crystal screen has made decisive progress in recent years, especially with the development of the active matrix screen, in which each point of the image is controlled by an integrated transistor.

### In Clematite's Footsteps

A group of workers at the CNET Lannion B Center has developed such a liquid crystal flat screen, controlled by a thin film transistor matrix, and has integrated it into a black and white Minitel prototype. This was the objective of the CNET Clematite project (liquid crystals and integrated technology active matrix for terminal screen), which was conducted from 1983 to 1986.

However, compared with a more conventional technology (multiplexed screens), active matrices acquire their full potential for color picture displays. That is what motivated the CNET team to undertake, in the footsteps of the preceding program, the development of color flat screens for displaying natural color pictures.

To this end, the team led by Mr Le Contellec has perfected and patented a color filter fabrication technology that uses pigments dispersed in a photosensitive resin, whose interest lies in its use of technical methods similar to those used in fabricating the transistor matrix. Moreover, according to CNET, the process is expandable to the construction of large screens without significant cost increase.

In addition, for natural color pictures, the liquid crystal cell must operate as a variable optical gate, therefore displaying a large number of luminescence levels. CNET has therefore devoted exceptional care in the construction of the liquid crystal cell, both in the choice of materials and in its implementation, in order to obtain about ten levels of homogeneous luminescence over the entire surface of the screen.

The flat screen that was awarded the 1987 CNET Prize, has a working area of 8 cm X 8 cm, a resolution of 320 lines and 320 columns, which corresponds to 102,400 transistors, or to 24,200 colored triplets that allow color shadings. It can display fine resolution moving color pictures at a television display rate, and is particularly well adapted as a display for the visual phone terminal.

### Two Masking Operations

The construction of this flat screen uses an original fabrication technology for amorphous silicon thin film transistors, which CNET has developed as part of the Clematite project. This very simplified process requires only two photolithography steps, compared to four or five in competing laboratories.

Active matrix flat screens have already gone into production in Japan, where pocket television sets with such screens are already being sold. But the cost price is not what it should be, and Matsushita, Sharp, and Hitachi are looking for manufacturing processes simpler than the ones they are currently using.

CNET believes that it has a very competitive fabrication process: the interest demonstrated by the Japanese, notably Sharp, is a very good indicator of that. But a lot of ground remains to be covered, particularly in manufacturing yield, which for integrated circuits is known to determine a technology's production cost.

That is why the Lannion team is getting ready to enter a new phase, the installation of a pilot line capable of producing small batches of flat screens to prove that good yields can be obtained, and to thus formulate a manufacturing specification. This essential phase requires a green light from CNET's management (an unofficial approval has already been granted) and a financing of tens of million francs (which remains to be confirmed). This phase should start during this year, and last 18 months to two years.

### Industrial Solution

As it is, an industrial solution remains to be found. CNET and Sagem have started to discuss the appropriate legal entity for an association. The manufacturer is a large user of flat screens for its telecommunication equipment (it is the world's second largest in Telex, and one of the leaders in written communication), automobile electronics (it assembles the R 21's dashboard with Japanese liquid crystals), and navigation systems in the near future. Interested but careful, Sagem has not made a final selection between CNET's and LETI's technologies. After all, a mass production line does require an investment of the order of 250 MF. However, if the current discussions are successful, the pilot line would be built at Lannion with Sagem's participation.

The Japanese have shown that consumer products equipped with flat screens are marketable. But the manufacturing methods are not satisfactory, and CNET believes that there is room for the Europeans on this huge potential market. The time has come to get going.

Among the large manufacturers, Thomson has opted for a General Electric technology in the matter of flat screens—which has led to the creation of their joint subsidiary Eurodisplay—oriented primarily toward aeronautic applications, in keeping with its strategy redeployed toward the United States.

Philips in turn, has conducted research in Great Britain before moving into the development stage in the Netherlands. The contact it made with CNET has shown that it has obtained the same image quality with the same technology, but with different fabrication processes.

**France Opens First Part of 'RENAN' ISDN Network**

36980184c Paris *INNOVATION TELECOM in French*  
Jan 88 p 1

[Unsigned article: "ISDN Placed in Service"]

[Excerpts] The technical and commercial opening of the French ISDN (Integrated Services Digital Network) took place on 21 December 1987, at Saint-Brieuc.

The first 40 subscribers are connected to the E10B switchboard of Saint-Brieuc in Cotes-du-Nord. This event represents the first part of the VN1 stage of the CNET RENAN Project, which will be completed in Cotes-du-Nord in 1988, with the connection of about 300 subscribers distributed over the territorial department and in the city of Rennes. Following that, about

1000 subscribers will be connected in Paris and its eastern suburbs starting in the fall of 1988 (see IT Special 1987). ISDN will then gradually be spread over the entire country.

J. D. Lallemand, operations director in Rennes, established the first ISDN telephone communication with the president of the Cotes-du-Nord Chamber of Commerce and Industry, who at the time was at the Saint-Quay-Portrieux fish market. At the same time, a screen displayed a picture of the market, also transmitted by ISDN at 64 kbit/s.

This communication illustrated some of ISDN's technical possibilities: two simultaneous communications, excellent quality sound, and the transmission of slow pictures over a single telephone line.

11023

## ADVANCED MATERIALS

### Poland Computerizes Calculation of Composite Material Properties

26020010a Warsaw PRZEGLAD MECHANICZNY in Polish No 16, 1987 pp 11-14

[Article by Dr Kazimierz Pucilowski, associate of the Institute of Technical Mechanics, Warsaw Polytechnical Institute: "Theoretical Calculation of Composite Material Properties—Program of Computerized Calculation and Its Application in Experiments with Planned Composite Materials"]

[Text] Tests of anisotropic materials, primarily composites, are extremely laborious because they must determine numerous material constants and because composites are considerably more heterogeneous than traditional materials. Consequently, the results of tests are more broadly distributed and more samples are needed for every measuring point. Furthermore, the "cascade" effect of the more labor-intensive tests should be considered. It is therefore imperative to take advantage of the existing opportunities stemming from theoretical calculations which help reduce the laboriousness and cut the time needed for deriving the required data.

The application of experimentally verified theoretical calculations is also immeasurably more important in the planning of new composite structures. A very relevant specific aspect of composite materials is selecting, from a technical standpoint, their most advantageous structures and compositions in line with obtaining the physical properties, in terms of weight and function, desired in a proposed structural element. Therefore, the empirical selection of the composition and structure is very cost-intensive, but theory helps accelerate the planned process; unfortunately, for various reasons it has not been widely employed in engineering practice.

#### Method of Computerized Calculation

We present a program for theoretical calculation of the physical properties of composite materials, offering greater benefits from theoretical achievements and from their wider application in technology.

This method of calculation was devised by the Institute of Technical Mechanics at the Polytechnical Institute in Warsaw. Its logic diagram (presented in Fig. 1) is geared to the capacities of a user who is not familiar with the theory of reinforcement and the principles of mathematical processes. This is the first part of a more far-reaching program which includes complete calculations for the process of designing composite materials. The method described here makes it possible to use the computer to achieve optimum structural rigidity or flexibility of the planned composite materials. In addition, it is applied for the selection of components of the composite and for the optimum efficiency of tests.

An essential of this method is to determine the structure—or model configuration—of actual fiber composites as laminated materials. This program makes possible theoretical prognoses of the rigidity or flexibility of the composite, from the calculation of the technical constants of the elementary strata to the specification of the components of the flexibility and rigidity tensors of the whole composite and, if need be, the estimated composition of technical characteristics of the composite, i.e., the changes in the elasticity modulus, the rigidity modulus, Poisson's ratio, the Czencow coefficient effect as a function of the angle which defines the spatial orientation of interest to us. Moreover, this method makes it possible to apply experimental data for individual layers and for the whole composite.

For calculating the components of the flexibility tensor of the elementary stratum, the method employs two different reinforcement theories:

- the  $V_{an}F_oF_y$  model, and the
- interpolative model, which were confirmed by numerous theories<sup>1</sup> and proven the most suitable for this experiment.

#### Demonstration of the Accuracy of the Calculation Method

To demonstrate to the reader that these calculations are accurate, as an example, we'll consider a composite made of epoxy resin [reinforced] with carbon fiber with  $F = 0.6$ , made from preimpregnated F550 manufactured by the Hexcel Company, with unidirectional fiber arrangement, hardened at 120 degrees C, and described in detail in G. Scharr's dissertation<sup>2</sup>. The author's data concerning the properties of the composite are as follows: EW  $2.2 \times 10^5$  Mpa, NIW = 0.25, IM =  $3.5 \times 10^8$ , NIM = 0.35, and filling ratio  $F = 0.6$ .

Figure 2 depicts the change in the modulus of elasticity and the stiffness modulus. Fig. 3 shows the Poisson ratio and the effect coefficient of a composite with a unidirectional carbon filament layer (the elementary stratum) and orthogonal reinforcement. Dotted lines denote the experimental data. Compared to experiment, the calculations for this particular composite were off by less than 5 percent.

Composites of other types were tested by the Institute of Technical Mechanics; maximum differences in the properties of the reinforcement amounted to less than 10 percent.

#### An Example of the Method Applied in Tests of Design Structures of Composite Materials

Another example of results achieved by this method concerns tests of the thermal effect on technical constants of the composites. Data in the literature<sup>2,3)</sup>

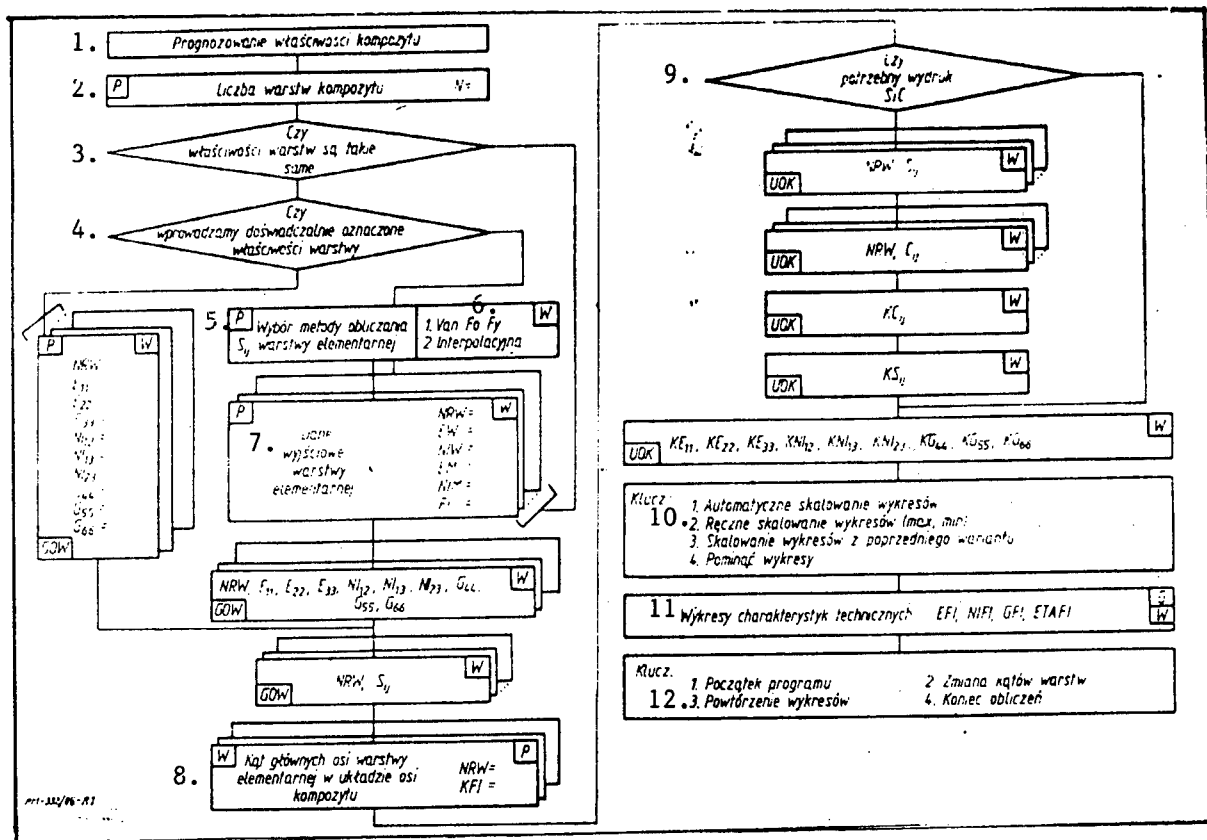


Fig. 1. Logical diagram of prognostic calculation:  $N$ =No. of strata;  $E_{11}$ ,  $E_{22}$ ,  $E_{33}$ =elasticity moduli;  $NI_{12}$ ,  $NI_{13}$ ,  $NI_{23}$ =Poisson's ratio;  $G_{44}$ ,  $G_{55}$ ,  $G_{66}$ =rigidity moduli;  $F$ =filling ratio (ratio of the volume of the fiber to the volume of the whole composite);  $S_{ij}$  ( $i, j = 1 \dots 6$ )=matrix of components of the flexibility tensor;  $C_{ij}$  ( $i, j = 1 \dots 6$ )=matrix of components of the stiffness tensor;  $W$ =print-out;  $p$ =power supply;  $GOW$ =main axes of the elementary stratum;  $UOK$ =position of the axis of the composite;  $G$ =graphics;  $NRW$ =No. of the stratum;  $EW$ =fiber elasticity modules;  $NIW$ =Poisson's ratio of the fiber;  $EM$ =elasticity modules of the base;  $NIM$ =Poisson's ration of the base;  $KFI$ =angle of main axes of the elementary stratum in the coordinate system of the whole composite'  $KFI$ =relative [dotyczy-word unknown] of the composite;  $IFI$ =value as a function of the change in the FI angle (0.2, 90);  $ETA$ =Czencow coefficient effect

Key:—1. Prediction of composite characteristics—2. No. of strata in the composite—3. Are the characteristics of the strata identical?—4. Have the characteristics of the strata been experimentally determined?—5. Method chosen for the calculation of the elementary stratum  $S_{ij}$ —6:1)  $V_{an} F_o F_y$ —2) Interpolative—7. Initial data for the elementary stratum—8. Angle of main axes of the elementary stratum in the coordinate system of the composite—9. Is there a print-out?—10:1) Automatically scaled diagram—2) Manually scaled diagram (max, min)—3) Diagram scaled from a previous variant—4) Diagram omitted—11. Diagram of technical characteristics EFI, NIFI, GFI, ETAFI—12:1) Start of the program—2) Change of the angles of the strata—3) Diagrams repeated—4) End of calculations

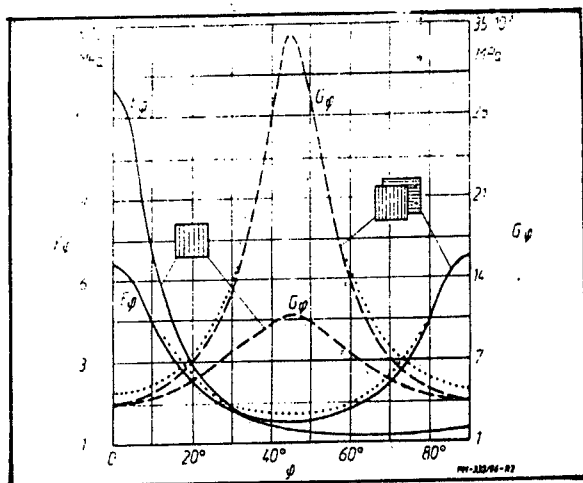


Fig. 2. Changes in the function of the angle of rotation of the elasticity modulus (solid line) and rigidity modulus (dashed line) of a composite with unidirectional filament arrangement and with orthogonal reinforcement; dotted lines - experimental data

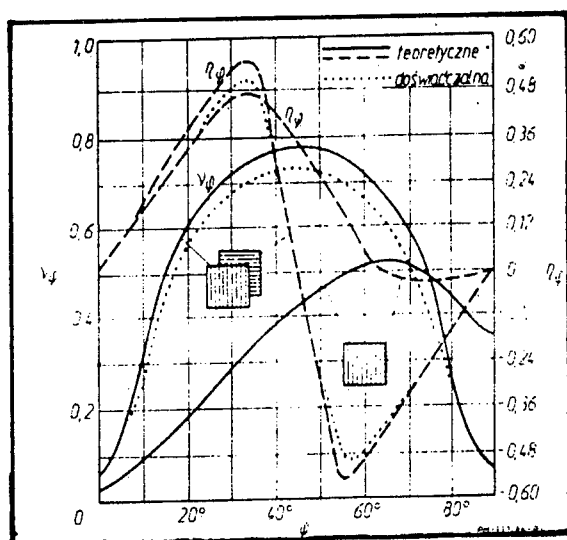


Fig. 3 - Changes in the Poisson ratio (solid line) and the effect coefficient (dashed line) of a composite with unidirectional filament system and orthogonal reinforcement as a function of the angle of rotation; dotted lines - experimental data

present results of tests conducted with various composites on polyester and epoxy bases, using fiberglass and carbon filaments. Table I presents the composites under study, among other things.

Table I. Characteristics of the Composites Under Study

The effect of the temperature on the technical characteristics of composite 2 is shown as an example in Fig. 4. The problem of the thermal effect on technical characteristics of the composite will not be discussed here in detail, since it has been described at length in<sup>[3]</sup>. Nevertheless, it should be emphasized that the changes observed in the technical characteristics permit us to state that, in general, the greatest changes in technical constants under the effect of the parameter discussed here do not appear along the principal axes of anisotropy. This effect is misleading because it renders the results of the tests considerably less accurate. A proper choice of the optimal processing mode for the specimens obtained considerably enhances the accuracy of the studies.

From the structure of the composites presented in Table I, it is evident that composite 3 was made from the same components as composites 1 and 2. A data analysis shows that while the technological equipment remains the same, the filling ratio of a composite with a compound structure does not directly depend upon the filling ratio of the structures of its components.

This relevant technological corollary is an important factor to be considered in the planning of composites with new structures. However, theoretical calculations of the thermal effect upon the technical constants of composite 3 may be verified on the basis of the data from experiments with pure resins and for composites 1 and 2. From an analysis of the structure of the composites under consideration and their filling ratios it was calculated that composite 3 may be designed as a composite with 3 elementary strata, i.e., layers of the same type as in composite 1 and composite 2, and of pure resin layers, the ratio being 8.88:4.04:2.53.

Theoretical calculations of a composite designed along these lines were compared with experimental data (Table II). The values of constants  $E_{ij}$  and  $G_{ij}$  are expressed in MPa. For a more detailed analysis, Table II includes the standard deviation of the tests and the absolute and proportional difference in theoretical and experimental values. The results presented here permit us to conclude

TABLICA 1. Charakterystyka badanych kompozytów					
1. Kompozyt	2. oznaczenie	3. budowa	4. Osnowa	6. Typ wzmacnienia	10. Objętościowy stopień napełnienia
1		x x x x x x x x x x x x x x x x x x x x	5. Żywica poliestrowa Lequval W25 <sup>R</sup> , jednakowe warunki utwardzania	Mata szklana typ M 123-50, gramatura 450 G/m <sup>2</sup>	23%
2		+ = + = + + = + = + + = + = + + = + = +		Tkanina szklana (ortogonalna 1:1) 8. typ 92140, gramatura 390 G/m <sup>2</sup>	30%
3		+ = + = + x x x x x + = + = + x x x x x + = + = +		11 warstw maty, jak w kompozycie 1 oraz 12 warstw tkaniny, jak w kompozycie 2 9.	21%

Key:—1. Composite—2. Designation—3. Structure—4. Base—5. Polyester resin Lequval W25<sup>R</sup>, identical hardening conditions—6. Type of reinforcement—7. Type M 123-50 glass mat, weight per unit of area 450 G/m<sup>2</sup>—8. Fiberglass fabric (orthogonal 1:1), type 92140, weight per unit of area 500 G/m<sup>2</sup>—9. 11 mat layers, as in composite 1 and 12 layers of fabric, as in composite 2—10. Volumetric filling ratio

that the differences in elasticity modules  $E_{11}=E_{22}$  do not exceed 2 percent, and 5 percent  $E_{33}$ . For the rigidity modulus,  $G_{13}$ , the figure is 8 percent; for  $G_{12}$ , 30 percent; for the Poisson ratio,  $\nu_{21}$ , 7 percent; for  $\nu_{13}$ , 27 percent, and for  $\nu_{31} = \nu_{32}$ , 4 percent.

Thus, the greatest differences appear in the technical constants  $G_{12}$  and  $\nu_{13} = \nu_{23}$ ; however, it may be said with complete assurance that the actual value is somewhere between the given experimental value and the theoretically calculated one. This follows from the fact that the samples for which these constants were measured consisted of several components of plates glued together in plane 1 - 2. Although, in G. Schar's opinion<sup>[2]</sup>, the median thickness of the glue joint does not exceed 0.1 mm and thus, it was omitted in the processing of the data, the specimen (as the data indicate) consists of about 20 such lengthwise glue joints which, in their totality, may significantly affect the measurement of the constants  $E_{33}$ ,  $G_{12}$ , and  $\nu_{13} = \nu_{23}$ . The extent of that effect depends on the placement of extensometers and increases with the temperature, particularly in case of the rigidity modulus and the Poisson ratio. The phenomenon is clearly evident from the data in Table II. Approximate estimates based on the presumed number of 0.1 mm glue joints (after all, glue joints may vary) have shown that the differences between properly conducted tests and applied theoretical calculations certainly should not exceed 10 percent.

#### Summary

The examples presented here should convince the reader that the application of the method of theoretical calcu-

lation discussed in this paper is advantageous in engineering practice. This method replaces tedious experiments with fast theoretical calculations which on the whole produce sufficiently accurate results as regards technical applications (percent), often within the limits of the diffusion of experimental studies. This method may be applied for all types of composites with continuous filaments and for other materials with laminated structure. To guarantee the accuracy of the accepted theoretical model, only partial experimental verification is sufficient for the projected boundary values and the parameters under consideration. Proper application of the program discussed here will permit, for example in <sup>[2]</sup>, the reduction of the laboriousness of the tests conducted by a factor of two-thirds. Moreover, the method discussed here makes possible the most practical theoretical selection of the composition and structure of planned composites.

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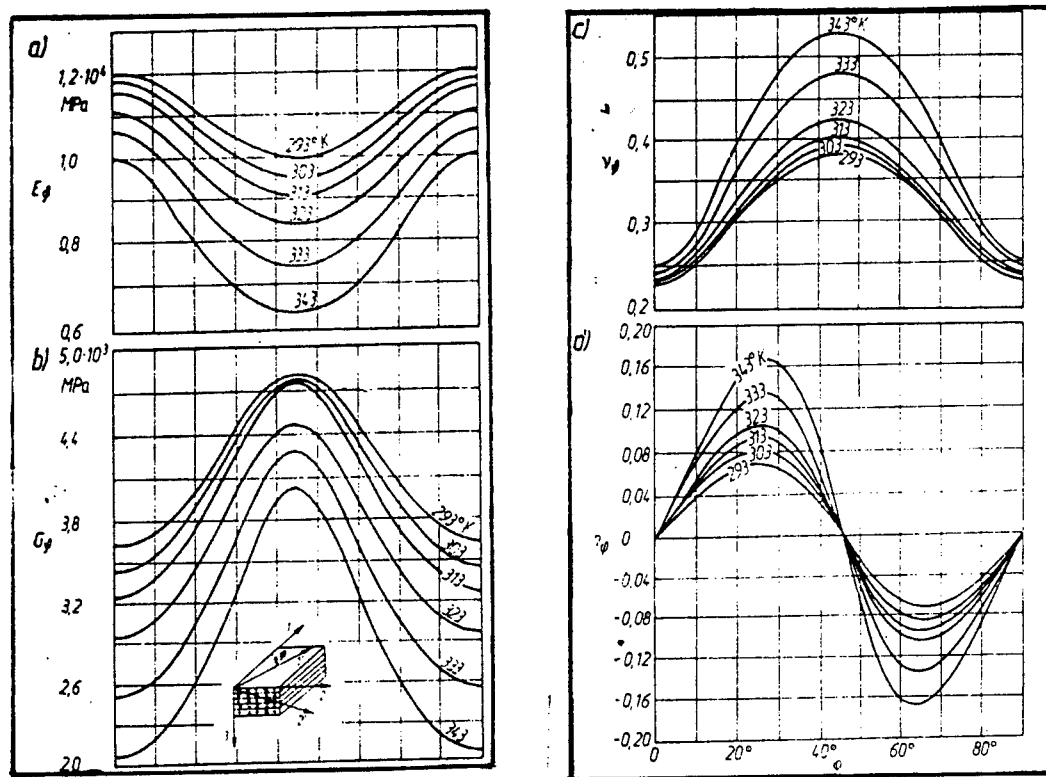


Fig. 4. Effect of the temperature on technical characteristics of composite 2: a) - elasticity modulus; b) - rigidity modulus; c) - Poisson's ratio; d) - effect coefficient

# COMPUTERS

## Hungary: Computer Industry in Serious Need of Imported Parts

25020035 Budapest FIGYELO in Hungarian  
No 4, 28 Jan 88 p 14

[Interview with Gabor Szeles, president of the Instrument Technology Small Cooperative, by Peter Felix: "We Have To Import Parts"]

[Text] The Instrument Technology Small Cooperative is one of the firms dealing with the dynamically developing domestic computer manufacture and assembly. They are counting on a net profit of more than 150 million forints on trade last year of 1.4 billion. We asked president Gabor Szeles what, in his opinion, would be the effect on Hungarian computer manufacture of the recently passed private import restrictions.

FIGYELO: To what extent did this measure catch you unawares?

Gabor Szeles: It is probable that everyone in the business knew about it; for a year and a half we have been expecting such a measure.

FIGYELO: Was there a feeling, simply because the decision hung fire for such a long time, that one did not have to take it seriously?

Gabor Szeles: Earlier, in the middle of 1987, we took very seriously the reports which had leaked out, but now, at the beginning of 1988, the decree comes out and we were surprised. We do not consider the timing fortunate. Easing travel conditions might have moderated prices primarily on the market for smaller items but for larger computers as well. It is true that for a few years many might have lined their pockets through private import, but in my opinion the swift development of computer technology would be more than worth it. In addition the profit which might have been made would have diminished quickly due to increasing supply. And still in 1986 the OMFB [National Technical Development Committee], in cooperation with the Ministry of Industry and the OAH [National Materials and Price Office], created a competition with the aid of which a build-up of domestic computer manufacture and background industry appeared realistic—at least over the long run. This year, because of the import restrictions, demand will be substantially greater than calculated on, and it cannot be satisfied with domestic manufacture. So yielding to increasing pressure either they will import Western or Taiwanese computers, or parts according to another idea, centrally or a shortage economy will return. Again customers will have to wait 6 months or a year to get a computer. It will slowly become clear to every enterprise and economic leader that without computers and programs they cannot compute the grossings and progressive personal income taxes. We did a calculation which proved that it will be impossible to solve these tasks

1. Tem- pera- tura	2. Stale techniczne	3. Wartosc doswiadc- czalna	4. Odchy- lenia standar- dowe	5. Wartosc teore- tyczna	6. Różnica 7. be- zwzględna	
					%	
20°C	$E_{11} = E_{11}$	12010	422	11967	42	0,35
	$E_{12}$	6519	110	6679	160	2,45
	$G_{11} = G_{11}$	1955	37	2100	145	7,42
	$G_{12}$	3625	116	3777	152	4,19
	$r_{11} = r_{11}$	0,25	0,004	0,246	0,004	1,6
	$r_{12} = r_{12}$	0,215	0,008	0,202	0,013	6,05
	$r_{13} = r_{13}$	0,351	0,019	0,355	0,004	1,14
30°C	$E_{11} = E_{11}$	11806	272	11609	197	1,75
	$E_{12}$	6373	137	6516	143	2,24
	$G_{11} = G_{11}$	1862	48	1924,3	62	3,33
	$G_{12}$	3418	147	3616,8	198	5,79
	$r_{11}$	0,236	0,006	0,230	0,006	2,54
	$r_{12} = r_{12}$	0,220	0,006	0,187	0,033	15,0
	$r_{13} = r_{13}$	0,360	0,012	0,360	0,0	0,0
40°C	$E_{11} = E_{11}$	11566	316	11465	101	0,87
	$E_{12}$	5715	63	5978	263	4,6
	$G_{11} = G_{11}$	1701	56	1732	31	1,82
	$G_{12}$	3215	183	3400	185	5,75
	$r_{11}$	0,225	0,008	0,240	0,015	6,66
	$r_{12} = r_{12}$	0,221	0,005	0,192	0,029	13,12
	$r_{13} = r_{13}$	0,371	0,014	0,365	0,006	1,62
50°C	$E_{11} = E_{11}$	11004	310	10967	37	0,34
	$E_{12}$	5318	132	5555	237	4,46
	$G_{11} = G_{11}$	1500	53	1511	11	0,73
	$G_{12}$	2926	179	3126	200	5,08
	$r_{11}$	0,233	0,004	0,243	10	4,29
	$r_{12} = r_{12}$	0,221	0,006	0,197	0,024	10,86
	$r_{13} = r_{13}$	0,388	0,012	0,375	0,013	3,35
60°C	$E_{11} = E_{11}$	10579	302	10467	112	1,06
	$E_{12}$	5000	124	5151	151	3,02
	$G_{11} = G_{11}$	1261	48	1282	21	1,67
	$G_{12}$	2496	167	2909	473	18,95
	$r_{11}$	0,242	0,004	0,244	0,002	0,83
	$r_{12} = r_{12}$	0,228	0,004	0,198	0,030	13,13
	$r_{13} = r_{13}$	0,396	0,009	0,401	0,005	1,26
70°C	$E_{11} = E_{11}$	9956	501	10028	71	0,71
	$E_{12}$	4443	133	4662	219	4,93
	$G_{11} = G_{11}$	1012	46	1058	46	4,54
	$G_{12}$	2058	171	2658	600	29,15
	$r_{11}$	0,246	0,004	0,235	0,011	4,47
	$r_{12} = r_{12}$	0,261	0,005	0,193	0,068	26,05
	$r_{13} = r_{13}$	0,423	0,005	0,414	0,009	2,13

Key:—1. Temperature—2. Technical constants—3. Experimental value—4. Standard deviations—5. Theoretical value—6. Difference—7. Absolute

3. Pucilowski, K., and Scharr, G., "The Effect of Temperature on Technical Characteristics of Fiber-Reinforced Plastics." Eleventh Scientific Conference "Reinforced Plastics 1986," Dresden, 1986.

## Footnote

Dr Kazimierz Pucilowski, graduate of engineering, is an associate of the Institute of Technical Mechanics at the Polytechnical Institute of Warsaw.

without computerization at firms larger than 50 persons. So we predicted that one can expect this year an extraordinarily serious increase in demand for both hardware and software. We are feeling this already. In earlier years it was characteristic of January and February that we had only some orders, but now we received 200 million in orders in the first 2 weeks. Overall, in my opinion, demand for PPC's [professional personal computers] will at least double and with the loss of private import, representing nearly 40 percent of the market, demand will at least double so I am calculating on an almost four-fold tension increase. I do not think it probable that this can be counterbalanced at the state level with various import allotments. As I see it the shortage will become a permanent one all year due to the elimination of private import. If the winners of the earlier mentioned competition are not able to increase their manufacturing capacity, because they do not have the foreign exchange to cover the dropping out of private import, then the entire OMFB policy could go bust.

FIGYELO: Won't the stopping of private import improve the position of domestic manufacturers?

**Gabor Szeles:** For the time being there can be no domestic manufacture without the parts and components brought in by private import. If the restriction had been introduced 3-4 years later then this would not have presented any problem. But now those in whose interest this is can say that Hungarian manufacture was unable to increase, cannot satisfy the demand, so the correct path would be to import computers. The state must make a decision in this question within a relatively short time. Either it should encourage greater parts import and try to stimulate domestic manufacture or it should import computers in large lots from Taiwan. If the latter alternative is realized we would be very bad off, for we have invested considerable sums in building a manufacturing base and on continual improvement of manufacturing technology. The import of finished machines could frustrate in large measure the initiatives in this direction.

FIGYELO: Despite this it appears to me that the present situation could be a godsend for Instrument Technology, for you did not set up for tourist import of finished products but rather you assemble and even manufacture computers. How will you react to the price increasing trends caused by the shortage?

**Gabor Szeles:** First of all let me say that a breaking-up process is beginning. This means that tourists will travel out more often and bring in little by little what previously they paid duty on at one time. So probably even goods worth less than 25,000 forints will become more expensive. Now one can buy a mark deriving from private import for 80-85 forints. This means that machine prices will increase by 40-45 percent, if there is not a suitable compensation allotment expansion. Naturally I would be lying if I said that we will not exploit our situational advantage. Probably our prices will develop according to supply and demand.

FIGYELO: Do you see some way out of this complicated situation?

**Gabor Szeles:** It would help a lot if firms actually dealing with the manufacture of computer technology articles were to get the right, similar to Akadimpex, of buying the foreign exchange of those with a foreign exchange account at a price higher than the MNB [Hungarian National Bank] rate of exchange. On the one hand in this way we would get what we need and on the other hand, because of the larger volumes, we might get a more favorable price abroad.

Of course I would consider it optimal if instead of importing finished machines they would increase the allotments which could be competed for, from which the manufacturers might freely import from capitalist countries the parts important for them. I feel that this would help most of all the development of domestic computer manufacture.

8984

## FACTORY AUTOMATION, ROBOTICS

### Overview of CNC Machining Center Production at Hungary's SZIM

25020034 Budapest NEPSZAVA in Hungarian  
2 Feb 88 p 4

[Article by Tibor Flanek: "One of the Three Europeans"]

[Text] If there is a machine industry product which can be sold for 2 million marks per unit, and to demanding West German customers sight unseen, then it must be in the European front rank in modernness and quality. Well, there is such a machine, and it is a Hungarian one. The CNC machining centers of the Machine Industry Works can be sold for even higher prices on the FRG market. And they pay the price for them. They say that three firms on the old continent are capable of making them. One is the SZIM [Machine Industry Works].

It is true that the SZIM could not always do so. But now Matyas Jakab, the director general, is satisfied with the performance he undertook to offer: "Last year our sales receipts increased by a good 500 million forints, and the SZIM became a 5 billion enterprise." He shows me the data. "Our profit is expected to be around 700 million forints, and out of this we can pay the last installment on our debt."

### A Strengthening Diet

Within a few years the enterprise had to free itself of an oppressive billion forint debt, and now it has succeeded—entirely on its own. The new leadership which got started in the 1980's basically transformed the

Machine Tool Industry Works. The structural transformation so much talked of today is no slogan here; it is a radical practice which began years ago and continues today.

There was a slimming diet in this process too; they sold factories and personnel fell from 6,526 in 1980 to 4,511 today. But in the meantime the production value and sales receipts of the enterprise more than doubled and in 1987, sales receipts per worker exceeded 1 million forints.

The structural transformation moved unambiguously in the direction of valuable machines embodying high level expertise. They had long ago abandoned manufacture of traditional lathes and milling machines; it is better to import these. But year by year one could see that the machines of the SZIM were selling at higher, better prices. The decrease in the number of machines manufactured indicates this too; in 1986 more than a thousand were made in the factories of the enterprise but last year they made only 877, and their sales receipts increased by half a billion forints. Within this the ratio of convertible export last year was 12 percent higher than in the preceding year, exceeding 17 million dollars as a whole.

"Our machines are sold on the most demanding Western European markets," the director general said looking up from his figures. "Our biggest customers are famous FRG firms but we have delivered and are delivering to other Common Market countries and to Scandinavia. These countries have no payment problems, we don't have to ship on credit, and they pay with good money, with hard foreign exchange."

It is not easy to get these markets but it already appears that the SZIM has succeeded in strengthening its positions. The valuable, powerful machines, which can process parts weighing several tens of tons with a single grasp, compare in every respect with the competitive offerings. And, although they deliver these to the FRG with Siemens controls, only because of the service requirements, there are already versions of them—and these have been sold on other markets too—which are also capable of machining the most complex surfaces. The controls needed for these are unambiguously peak technology, which cannot be purchased from the West because of the embargo (COCOM) list, but the Esztergom milling machine factory of the SZIM and experts from Vilati and the machine manufacturing technology faculty of the Budapest Technical University have succeeded in developing them.

#### Both Sides of the Wage Club

Having such products the enterprise can enter the market confidently, and thanks to the successes of recent years the self-confidence of the people has strengthened as well. They know what they are capable of. Perhaps this

was why the transition from 1987 to 1988 caused no shocks in the process of production. Of course a determining role was also played by how the enterprise prepared for it.

"According to us the end of the year, or the beginning of the new year, is only a milestone," Matyas Jakab said. "After the holidays we took up where we had left off. We began January with orders for about 50 percent of the annual turnover. This situation is somewhat better than in the preceding year but it is not extraordinary. And I might call the supply situation relatively adequate—we can produce—but in addition I consider it very essential that the mood here is good. Going beyond the feeling of success it is based on the fact that the performance of the enterprise last year made possible an average 13 percent increase in earnings, which raised the average earnings above 99,000 forints per year."

"In a word, they are satisfied?"

"I wouldn't say that," the director general paused. "We really ask a lot of people. We have gotten to the point where we can pay for the diligence but we can't yet pay for the expertise. 1988 will be very difficult from this point of view. The requirements are even more strict now, and we cannot even promise to preserve real wages. The centrally authorized 2.5 percent increase is too little for this."

"Are you thinking of wage club membership?"

"We are just on the edge in regard to every single condition for wage club membership. So even today we can't be entirely sure which side of the line we will be on by the end of the year. Our application to the wage club is justified, but in practice we could put this into operation, could take advantage of the opportunities accompanying it, only if there were a guarantee that we could fulfil all the requirements. But even then it's not a free ride. The new tax system has greatly increased the costs sensitivity of the firm, including the fact that the personal income tax has made wages much more expensive. In a word, even with wage club membership we could increase earnings only sedately."

"How will the position of the enterprise change as a result of the new taxation?"

"Our profit will be about half of last year's, but of this we expect somewhat more to remain at the enterprise, so our freedom of movement will expand somewhat. In any case there are still things we do not know, there is some uncertainty, but if sales of the machines go well, if technical development progresses and we take the measures necessary to increase efficiency, then it will not cause much trouble. In any case the price/costs structure of the enterprise will be fundamentally transformed as a result of the new taxes."

### The Basis for Self-Confidence

The SZIM has cover for the much mentioned grossing and the shop stewards unanimously adopted a method of grossing which made it possible to increase somewhat the net earnings of those paid by performance.

"We have made some of the sliding wages into base wages, so everyone feels better about it," Matyas Jakab explained. "We are implementing the decisions of the government in a disciplined way, but some elements of them are very, very strict. I trust that we can bear it for a year."

The leadership of the SZIM is working calmly even now. There is a good chance for another 12 percent increase in convertible export because already in January there were contracts for a quarter of the planned volume and discussions under way for 60-70 percent. And the fact that the indebtedness of the enterprise has been abolished will make it possible for them to think of technological development too, bridging the gap between the European level of the products and their manufacturing conditions. They have not had the money for this so far but last year they did realize a technological investment from a 160 million forint loan assumed from the City Bank.

An optimistic enterprise leadership at the beginning of 1988? It is not a general thing. When I sought an explanation for this I found that the Budapest factory director named on 1 January is only 36 years old. The directors in Esztergom and Kecskemet—both have been in their posts for 2-3 years—are 46 and the new chief bookkeeper starting 31 March is only 28. The list could be continued with main department chiefs between 28 and 35 years of age. In a word, the average age of the SZIM leaders has become much younger recently. And this staff—together with the 55 year old director general—is also young in mentality.

And this is no little thing!

8984

## MICROELECTRONICS

**Problems in Czech GaAs SDFL Circuit Design**  
*24020008 Prague SLABOPROUDY OBZOR in Czech*  
*No 11, 1987 pp 529-533*

[Text]

### 1. Introduction.

One of the many possible uses of gallium arsenide is the fabrication of fast digital integrated circuits (ICs). In comparison with silicon ICs, the GaAs circuits are much faster while consuming less power. To make this goal a reality, a host of technological problems in preparation of semi-insulated GaAs materials had to be solved.

Recently a commercial fabrication of first GaAs digital ICs was announced abroad (1, 2, 3). Fabrication of logic IC prototypes from Czech GaAs material is discussed in references 4 and 5. This article deals with some questions in circuit analysis of these prototypes, and lists their researched characteristics.

### 2. NOR Gate

The basic building block of GaAs SDFL (Schottky Diode FET Logic) circuits is a NOR gate. Its circuit diagram is shown in Figure 1. The NOR gate is constructed from FET transistors and Schottky diodes. The transistors operate in a depletion mode (D-MESFET) with a threshold voltage  $V_{th}$  approximately equaling -1 V. The logic summation is realized by input diodes (LD in Fig. 1). In theory, it is possible to connect any number of such inputs; in practice, however, from topological reasons only 8-10 are used at the most. The circuit following the input diodes is designed with the shifting diodes (SD) and MESFET transistor with shorted gate (PD), connected to a negative supply  $V_{ss}$  approximately equals -1.5 V. The function of this circuit is to shift the voltage level to a value needed to operate the gate of the switching transistor (ST). The logic of this transistor is again a MESFET with shorted gate (PU), with a collector connected to a positive supply  $V_{dd}$  approximately equal to 2.5 V.

### 3. NOR Variations, Other Circuits

D-MESFET transistors as mentioned above are used to construct the NOR gate. It is evident that logic output gain ("fan-out") is determined by a load transistor's saturation current, if output is a logical "1". Single output gate can have, from technological reasons, a logic gain of about 2. If needed, the two transistors buffered output (Figure 2) can provide a logic gain of 4 to 10.

The SDFL circuit approach offers a simple way to attain the logical product of at most two variables. It can be realized with a two gate switching transistor (Figure 3) or two switching transistors connected in series (Figure 4). The number of product variables in OR/NAND gate (Figure 5) is limited in the first place by delay of a multigate transistor and in second place, by increasing the logic levels introduced by the serial connection of the transistors. Logical function OR/NAND connected to inverters will realize an inequality function XOR (Figure 6), with delay of only 2  $T_d$ , where  $T_d$  is a one-gate delay.

Because the SDFL should be compatible with ECL and TTL/CMOS circuitry, it is desirable that SDFL chips also contain logic level translators with sufficient logic gain. The diagram of a voltage translator from ECL to SDFL and back is shown in Figure 7. Because the translator output is designed to drive a 50 Ohm load, output transistors connected in cascade are used. These transistors are also used in translations from SDFL to TTL/CMOS to assure sufficient propagation speed compatible with TTL circuitry (6) (Figure 8).

NOR gate can also be used in sequential circuits. Figure 9 shows an example of a D flip-flop used as a basic building block for frequency dividers. In this configuration maximum input frequency of the divider is  $1/5 T_d$  (7). The output of NOR gate is either buffered or not, depending on a number of driven inputs.

#### 4. Technology

As an initial material for IC fabrication (5) the semi-insulated GaAs doped with chromium was used. Active elements were produced by a double selective ion 28 Si<sup>+</sup> implantation through the photoresistive mask. Shallow implantation n- (dose  $3 \times 10^{12}/\text{cm}^2$ , 160 KeV) is localized in the channel region of the transistors. The deeper implantation n+ (dose 5 to  $8 \times 10^{12}/\text{cm}^2$ , 200 KeV) is used for fast input diodes. The combination of both is used for shifting diodes and under resistive contacts.

The implanted GaAs wafers were covered by a layer of a pyrolytic SiO<sub>2</sub> (thickness 400 nm). This layer is needed to produce the layered structure of ICs and it also assures a passive surface during implantation. Active elements were etched into SiO<sub>2</sub> with plasmas.

The resistances of Au-Ge/Ni types were produced with a vacuum evaporation. Specific contact resistance reached 1 to 2 times  $10^{-6} \Omega \text{ cm}^2$ . Schottky contacts of Ti/Pd/Au were produced with a vacuum sputtering with the following parameters: ideal coefficient  $n=1.19$  to 1.30 and a height of a potential barrier  $\phi_{Bn}=0.6$  to 0.65 V.

Metal patterns were shaped with a "lift-off" technique. Optical lithography was used for individual fabrication levels. The characteristics of contacts and basic circuit elements (diodes, transistors) were verified on the testing samples.

Part of the GaAs test chip, designed with NOR gates (cf. Figures 1, 2), fabricated with aforementioned technology is pictured in figures 10 and 11. There the length of transistor gates is 3.2 micrometers, the width of a switching transistor is 35 micrometers. More detailed information about fabrication of GaAs wafers with test samples and ICs is given in references 4 and 5.

#### 5. Gate characteristics.

To measure static characteristics of produced ICs the operating condition had to be established. Not enough practical experience with the fabrication process, based on SDFL circuit approach, was accumulated. Therefore, to satisfy the input, output and transfer characteristics, the logic levels and supply voltages were determined from a vast collection of technological results and statistically evaluated measurements. According to these specifications some circuits were selected while still on a wafer, not diced, and some right after encapsulation. The operating conditions can be summed up this way:

1. Supply voltage:  $V_{dd}=3 \text{ V}$ ,  $V_{ss}=-1.5 \text{ V}$ .

2. Logical "1" input voltage, present on at least one input to give logical "0" at the output:  $V_{in}(1)$  equal or greater than 2.3 V.

3. Logical "0" input voltage, present on all inputs to give logical "1" at the output:  $V_{out}(0)$  equal or smaller than 1 V. Unused inputs are at logical "0".

4. Logical "1" output voltage:  $V_{out}(1)$  equal or greater than 2.5 V.

5. Logical "0" output voltage:  $V_{out}(0)$  equal or smaller than 0.8 V.

6. Logical "0" input current:  $I_{in}(0)$  equal or smaller than 100 microamperes at  $V_{in}(0)=1 \text{ V}$ .

7. Logical "1" input current:  $I_{in}(1)$  equal or smaller than 200 microamperes at  $V_{in}(1)=2.3 \text{ V}$ .

Typical measured characteristics:

8. Short circuit output current at  $V_{in}(0)=1 \text{ V}$ : NOR, OR/NAND gate:  $I_{os}=0.75 \text{ mA}$ , NOR buffer:  $I_{os}=5 \text{ mA}$ .

9. Current supplied by  $V_{dd}$ : at  $V_{out}(0)$ :  $I_{dd}(0)=800$  microamperes, at  $V_{out}(1)$ :  $I_{dd}(1)=25$  microamperes.

$I_{dd}$  measured with no load on the output,  $V_{in}(1)=2.3 \text{ V}$ ,  $V_{in}(0)=1 \text{ V}$ .

10. Current supplied by  $V_{ss}$ : at  $V_{out}(0)$ :  $I_{ss}(0)=200$  microamperes, at  $V_{out}(1)$ :  $I_{ss}(1)=100$  microamperes.

$I_{ss}$  measured with no load on the output,  $V_{in}(1)=2.3 \text{ V}$ ,  $V_{in}(0)=1 \text{ V}$ .

Typical transfer characteristics of different types of ICs are shown in Figure 12. From Figure 12 it is evident that the characteristics for NOR and NOR buffer gates are similar. OR/NAND output voltage characteristic is partially different due to transistors connected in series which perform the logical product function. The voltage on the two open transistors with outputs at logical "0" is therefore higher than the voltage of other types of ICs.

Inputs of all ICs are handled in a similar manner which results in identical characteristics. According to the load characteristics at logical "1" voltage, the fabricated ICs can be divided into two groups. First, the circuits designed with NOR and OR/NAND gates as in curve a, Figure 13. Second, ones designed with NOR buffers, curve b, Figure 13. From input and load characteristics it is evident that NOR and OR/NAND gate outputs can be loaded with 2 inputs, whereas NOR buffer outputs can be loaded with at least 4 inputs.

The dynamic characteristics were measured with an oscilloscope. Measurements were taken directly off the wafer before dicing into chips and after encapsulation. A special high frequency probe was designed to perform wafer measurements. Interference of parasitic capacitances and inductances was limited by the probe's adjustable resistance. Satisfactory adjustment up to 200 MHz was achieved. The three inverter hybrid design oscillator's output voltage pulses measured by this method are shown in Figure 14.

It is evident from the picture that one-gate delay is 1.3 ns (the length of MESFET transistor is 3.2 micrometers). The power dissipation per gate was approximately equal to 20 mW, which corresponds to dynamic switching energy  $Pdtd$  approximately equal to  $3 \times 10^{-11}$  to the minus 11th power J.

## 6. Conclusion

The basic building blocks of GaAs digital ICs of SDFL type are NOR and OR/NAND gates. With the worked out technology (4, 5) the first Czech GaAs IC samples designed with these gates were produced. With repeated measurements the optimum operating conditions were established. The resulting measurements proved that this type of GaAs ICs is suitable for high operating speed and low power consumption.

To interface these circuits with silicon ECL, TTL or CMOS circuits, the input and output level translators were designed and fabricated.

The more complicated SDFL circuits are designed with more of these basic gates. The very progressive designs use the gate arrays. This subject will be discussed in detail in a separate article.

## Figure Captions

Figure 1. Circuit diagram of NOR gate. LD - input (logic) diodes, SD - shifting diodes, PD and PU - MESFET transistors with shorted gate, ST - switching transistor.

Figure 2. NOR buffer.

Figure 12. Transfer characteristics of gates. a) NOR, b) NOR buffer, c) OR/NAND.

Figure 13. Loading characteristics of gates (output high). a) NOR and OR/NAND, b) NOR buffer.

Figure 14. Output voltage pulses of a three-stage ring oscillator. 10 ns in horizontal, 1 V in vertical direction per division.

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13432/9738

76

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